UACOS

THE UKRAINIAN AMERICAN CHERNOBYL OCULAR STUDY

PROTOCOL

OCULAR RADIATION EFFECTS IN THE CHERNOBYL LIQUIDATORS

1994

TABLE OF CONTENTS

UACOS MEMBERS

United States Members | *Ukrainian Members*

Principal Investigators:

Academician* Prof. Basil V. Worgul, Ph.D.
Columbia University
Director, Eye Radiation and Environmental
Research Laboratory (ERERL)

Professor Ilia A. Likhtaryov, Ph.D.
Director, Department of Dosimetry
Ukrainian Scientific Centre for
Radiation Medicine (USCRM)

Program Management

Dr. Cecily Medvedovsky, M.D., Ph.D.
Eye Radiation and Environmental
Research Laboratory (ERERL)

Professor Roy Shore, Ph.D.
New York University
Director, Dept. Environmental Medicine

Academician Prof. Yuri I. Kundiev, MD, Ph.D.
Director, Institute of Occupational Health (IOH)

Acad. Prof. Nikolai Sergienko, M.D., Ph.D.
Director, Centre of Eye Microsurgery (CEM)

Program Advisors

Dr. Lynn Anspaugh, PhD.
LawrenceLivermore Laboratory
Director, Risk Sciences Center

Dr. Andre Bouville, Ph.D.
National Cancer Institute
Radiation Effects Division

Co-Investigators

Dr. Bin Wu, M.D., - ERERL

Dr. Vadim Chumak, Ph.D. - USCRM
Dr. George Parkhomenko, M.D. - CEM
Dr. Andre Ruban , M.D. - CEM
Dr. Peter Vitte, Ph.D. - IOH

* Foreign Member of the National Academy of Sciences

INTRODUCTION

In the early morning of April 26, 1986, reactor number four of the Chernobyl nuclear power complex underwent a power excursion resulting in a steam explosion which spewed solid and gaseous radioactive materials into the environment. From the initial explosion and during the subsequent hours to days, secondary releases, some as a direct result of an attempt to deal with the exposed core, caused a large civilian population to receive significant doses. The entire city of Pripyat (48,000 people) was evacuated 36 hours after the initial explosion, and a total of 116,500 people within a 30 km radius of the blast was relocated (Omelyanets et al., 1988). Together about 600,000 people were exposed to radiation from the accident (Sergeev, 1988). Those who were assigned the clean-up and maintenance duties in the months and years following the disaster offer a unique laboratory for the study of human radiation exposure at the individual and the populational level. The workers, conscriptees, and volunteer army, who comprised the so-called **"liquidators"**, numbered in excess of 200,000. Every effort has been made to determine the exposure level and fully define the population involved. A registry, "The National Registry of the Ministry of Health", has been established which is continually being updated. It contains 130,000 1986-1987 liquidators with a mean exposure of about 0.15 Sv. Up to 15% received >0.3 Sv and ~2% were exposed to doses greater than 0.7 Sv. While of little comfort to the victims, this tragic experience has produced a laboratory and a reference population which can be used to better understand radiation effects in the human population and develop the means to assess them. We hope to achieve both in the present collaboration by an intensive focus on the eye, with particular emphasis on the lens and its classic radiogenic pathology, cataract.

That cataracts arise from exposure to ionizing radiation is a fact which has historically been well appreciated by those involved in risk assessment and safety determinations. The lens, by virtue of its primary pathology, cataract, has enjoyed a long history as a sort of biological dosimeter. The first attempt at true calibration of this monitoring technique was done by Merriam and Focht in 1962 using a limited population of radiotherapy patients. Although relatively few low dose exposures were available (the total population numbered under 300 with 34 cases receiving less than 2 Gy) that work, suggested a threshold for cataract of 2 Gy. The most recent ophthalmic reevaluation of the Hiroshima data based on DS86 criteria suggests a minimum cataractogenic dose of about 0.7 Sv (the study group numbered about 1100 of which 32 received less than 2 Sv). A recent study of an American population (Beaver Dam, Wisconsin) (Klein et al., 1993) indicates a higher prevalence of posterior subcapsular cataracts in patients who had received CAT scans, suggesting that doses on the order of 10 to 30 cGy are cataractogenic. A recent report on ocular changes in children from exposed regions around Chernobyl indicate a higher than normal incidence of posterior subcapsular changes (Eller et al., 1993; Day et al., In Press). While the precise dose range cannot be ascribed to the exposed children it is very unlikely that it exceeded tens of cSv with a high probability than most of the children were exposed to a fraction of that. These data are consonant with experimental evidence (Worgul et al., 1993) suggesting the absence of a threshold for cataracts and therefore that the cataractogenic response to radiation is purely stochastic.

In terms of cataract in the Chernobyl population, it is becoming apparent that we are at the point when opacities are beginning to develop. The problem is that while radiation cataracts develop in a characteristic fashion, the changes are not pathognomonic. The clinical picture requires consideration of onset time, progression, and a robust personal history. Because it is clear that the population is available, ready to study, and the post-accident time is such that cataracts may be beginning to appear, we cannot afford to delay the initiation of an ophthalmological follow-up of the Liquidator population. This group represents the most dosimetrically defined of the Chernobyl population. Also, because their exposure was occupationally related, they are continuously monitored and readily available for longitudinal analyses. The situation provides an unparalleled opportunity to not only consider risk issues, but modalities for monitoring populations at risk and to test existing theories of radiation action on normal tissues in general, and the eye in particular.

OBJECTIVES AND SIGNIFICANCE

The ocular radiation protection standards formulated by national and international committees are all predicated on the assumption that there exists a high dose threshold for radiation cataract development. If, as the evidence is increasingly suggesting, this supposition is incorrect, the standards set for radiation workers as well as the population at large may not be appropriate. Clearly, in order to adequately protect those at risk of radiation exposure this question must be resolved.

The Chernobyl population provides, by its size, dose distribution and accessibility, the first opportunity to address the question of whether or not radiation cataracts are deterministic or stochastic. For the same reasons it will permit the determination of risk for cataract development from radiation exposure. In addition, it can supply the data necessary to determine the true potential for using cataract development as a tool to assess populations at risk and reduce uncertainties in retrospective dose reconstructions across populations.

There is, in force, an agreement between a number of Ukrainian Institutes, supported by the Ministry of Health, and the Eye Radiation and Environmental Research Laboratory (ERERL) of Columbia University to try to recover from the tragic incident of April 26, 1986 information for a better understanding of the effects of radiation on the eye, particularly as it relates to the lens and cataract and its utility in assessing risk to populations. The Ukrainian American Chernobyl Ocular Study (UACOS) is outlined in our agreement which is appended. The effort is tripartite in that there are three distinct thrusts with some complementary, but not overlapping, emphases. This proposal constitutes the primary objective of the UACOS - **To obtain reliable evaluations of the risk of cataract development in a dose defined population involved in the Chernobyl accident.** This will be the largest study ever conducted of radiation-induced lens opacities in a population with measured doses. It will have a range similar to the Japanese A-bomb ocular studies (Choshi et al., 1983; Otake and Schull, 1990) but will be 5 times as large.

The long range goals of our laboratory have been: to exploit radiation cataractogenesis for the purpose of assessing risk to individuals as well as to populations, to test theories of radiation action and to better understand the basis of cataract development in general. Each of these goals will be served by the proposed studies which have as their focus an exhaustive cohort epidemiological study with the development of a nested case control subset on a specific population of Liquidators.

Review :

Various studies of radiation effects on the eye have concluded that characteristically the initial lesion caused by ionizing radiation is the posterior subcapsular (PSC) cataract (Miller et al., 1967; Merriam and Worgul, 1983). In terms of "spontaneous" cataracts attributable to other causes including aging, PSC cataracts are relatively infrequent, constituting only 5-15% of total cataracts (Sperduto and Hiller, 1984, Adamson et al., 1991). The relatively low background rate of occurrence makes it easier to statistically detect an excess risk.

Radiation cataract was the first late effect of radiation to be documented among the Japanese A-bomb survivors (Cogan et al., 1949). The current epidemiologic database on radiogenic cataracts is relatively small and is marked by methodological limitations, some of which may have led to a questionable characterization of the risk function. For instance, the classic study by Merriam and Focht, based on a series of patients with prior radiotherapy, reported a threshold dose of 200 cGy (Merriam and Focht, 1957). However, only 33 patients with lens doses below 200 cGy were examined for cataracts in that study. The statistical power for detecting a modest sized risk with this small number of patients would be extremely low. The value of 200 cGy has nevertheless been commonly used by various radioprotection groups (ICRP, NCRP, UNSCEAR, BEIR) as an assumed threshold value for acute exposure, with even higher threshold values assumed for fractionated exposures.

In a recent reanalysis (Otake and Schull, 1990) of a 17-year collation of data on PSC cataracts among 2,124 subjects in the Japanese A-bomb study, the authors applied both non-threshold models that were linear or linear-quadratic in dose and models that contained dose thresholds. They found a slightly better fit from a dose threshold model (with an estimated threshold of 70 cGy) than from the non-threshold models, but the difference between the goodness-of-fits was small and far from statistical significance, and, in fact, the non-threshold linear-quadratic model provided an adequate fit ($p = 0.18$) to the data. It is of interest that there was a suggestive elevation of risk in their lowest dose group of 1-99 cGy, such that the relative risk was 2.1 ($p = 0.08$, 95% confidence interval 0.8-5.8) according to our calculations. It is also noteworthy that this, the largest epidemiologic study of radiogenic cataracts, had significant limitations in that it was based on only 792 persons and 15 recorded PSC cataracts in the dose range 1-99 cGy, and that the data were collected by various investigators which means that the ophthalmologic examinations were probably of variable sensitivity and quality (e.g., the most recent examinations were performed without pupil dilation [Choshi et al., 1983]). The most recent report, which found a better fit for a non-threshold linear dose-response function than from a threshold function, is difficult to interpret because it lumped together significant and very minor lens changes (Otake et al., 1992).

At the other extreme from those who regard 200 cGy as the threshold dose, Klein et al (1993) recently related PSC prevalence to anamnestic reports of diagnostic radiation. They reported that PSC cataract was related to a history of CAT scans (RR = 1.45, 95% confidence interval 1.08-1.95) and was suggestively related to diagnostic procedures to the head (RR = 1.27, 95% CI 0.96-1.66). However, these data should be interpreted cautiously, since the diagnostic radiation history was based on self-reports which are subject to recall bias.

Several studies have reported an inverse association between radiation dose and time to cataract presentation (Otake and Schull, 1990; Merriam and Focht, 1957; Merriam, Szechter, and Focht, 1972). This implies that there should be a long-term follow-up in a study that attempts to assess radiation risk of PSC cataracts at low doses. This is one of the reasons that we are planning a study with the possibility of extending out 15-years (i.e., with total follow-up for about 22 years after exposure), with a potential to extend the study to 25 years (total follow-up 32 years) if it seems warranted. Some (Choshi et al., 1983), but not all (Merriam and Focht, 1957; Otake and Schull, 1982), studies have also reported that the sensitivity of the lens to cataract induction is inversely associated with age at radiation exposure. This will be investigated as part of the proposed study.

A variety of other risk factors for cataracts have been reported. These include (see Bellows and Bellows; 1975) diabetes, diastolic hypertension and hypertensive drugs, phenothiazines and other major tranquilizers (Isaac et al., 1991), hypocalcemia, corticosteriods (Italian American Cataract Study Group, 1991; Jacques and Chylack, 1991), ultraviolet radiation exposure (Italian American Cataract Study Group, 1991; Leske and Chylack, 1991), cigarette smoking (Christen et al., 1992; Klein et al., 1993) and alcohol consumption (Munoz et al., 1993; Ritter et al., 1993). These factors need to be investigated as hypotheses in their own right-because some the evidence is marginal or inconsistent-and also as potential confounder variables in analyzing radiation effects.

Intake of several nutrients may lower cataract risk: carotenoids, vitamin A (Hankinson et al., 1992) and vitamin C (Jacques and Chylack, 1991; Hankinson et al., 1992)-although not all studies have been positive for these nutrients (Italian American Cataract Study Group, 1991; Hiller et al., 1983). The dietary factors merit further investigation, and the present population may provide an especially good opportunity to do so because the range of vitamin intake is likely to be greater than in studies in the U.S.

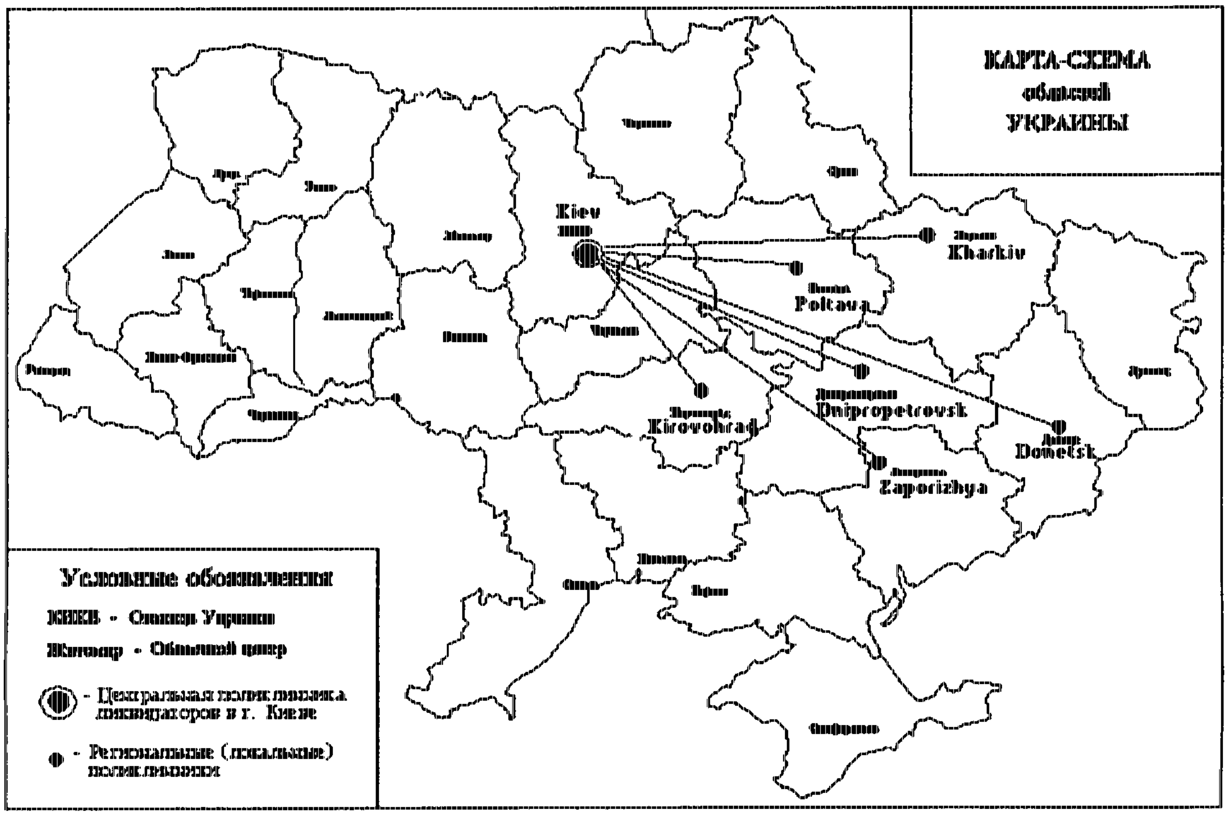
Therefore we plan a longitudinal study of cataract prevalence and incidence in a cohort of radiation-exposed Chernobyl Liquidators with the **following objectives**. 1) To determine whether there is evidence that the induction of posterior subcapsular (PSC) cataracts by radiation is a stochastic or a deterministic, process.

This implies that there would be excess risk at lower doses, rather than a dose threshold. This involves examining the dose-response relationship below about 70 cGy (which was the dose threshold estimated by the investigators of the A-bomb survivor data). 2) To determine the risk of radiation-induced PSCs among liquidators exposed to relatively high lens doses (≥70 cGy). This question needs to be examined because the exposures range from acute to protracted, unlike the A-bomb survivor study (Otake and Schull, 1990). 3) A secondary objective is to examine ultraviolet radiation exposure, smoking, alcohol consumption, diet (vitamins A and C, carotenoids)as co-factors in radiation cataract risk. The studies will be integrated into a fully inclusive ophthalmic screening (preventative medicine) program provided by the Ministry of Health, Ukraine.

RESEARCH DESIGN AND PROTOCOLS

ORGANIZATIONAL STRUCTURE

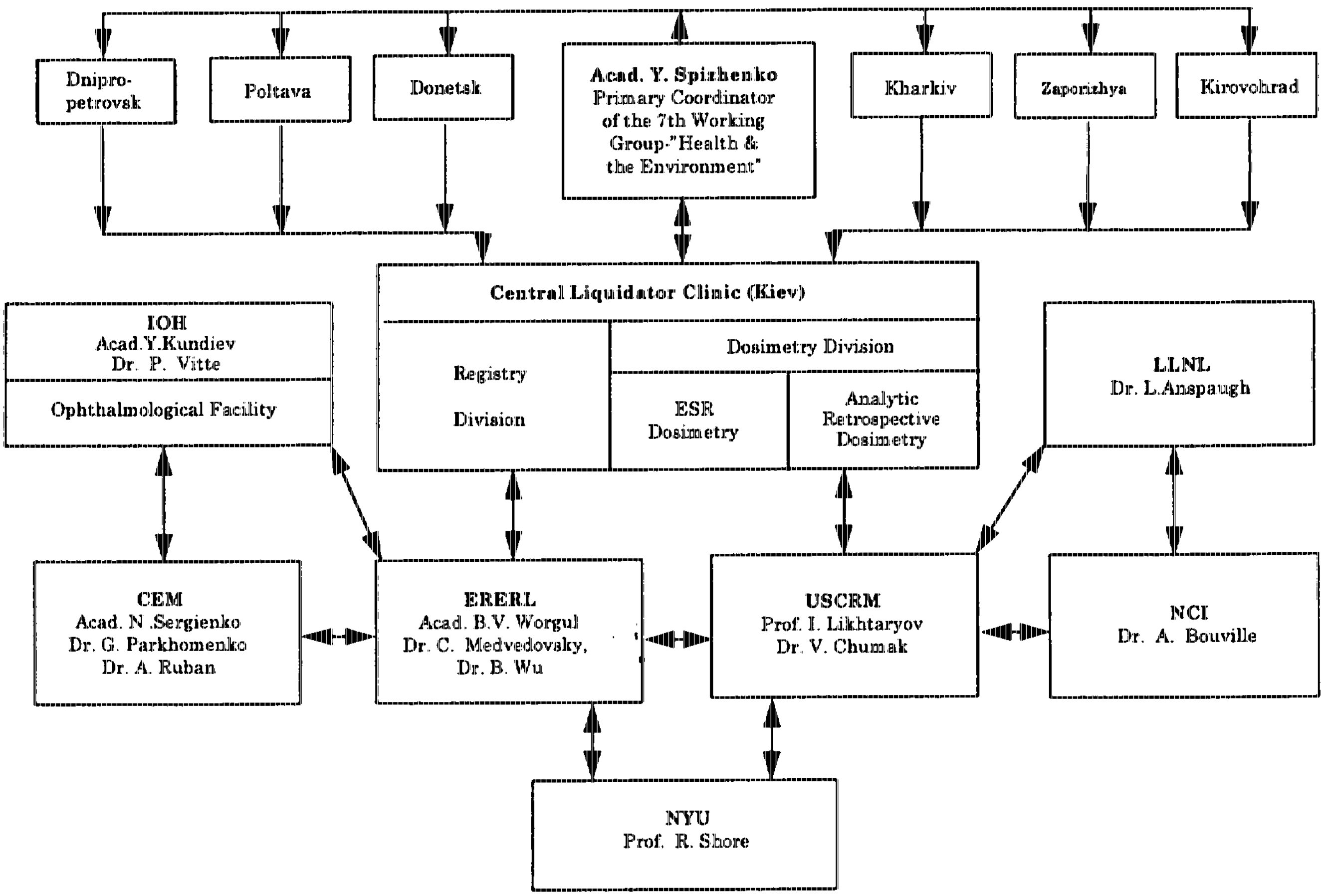
This protocol is designed to be compatible with existing arrangements between the Ukrainian ocular preventative disease programs at the Ministry of Health and the program for the present study. It represents an elaboration of an existing agreement between the principals establishing the Ukrainian American Chernobyl Ocular Study (UACOS). Biennial ophthalmologic examinations will be conducted to document the appearance of posterior subcapsular opacities and other opacities of the lens among the Chernobyl Liquidators. The 12,000 minimum cohort will initially include Liquidators whose real-time dosimetry will be confirmed by retrospective dosimetry and are part of the National Registry of the Ministry of Health. The examinations will be conducted at seven centers (see Map below) set up as dedicated clinics for Liquidator medical follow-up. Each is equipped for slit-lamp evaluation and ophthalmic assessment. As shown the clinics are distributed throughout Eastern Ukraine in the cities of Kiev, Kharkiv, Dnipropetrovsk, Donetsk, Zaporizhya, Kirovohrad, and Poltava. Together they provide the medical (including ophthalmologic) care of approximately 90% of the Liquidators



who reside in Ukraine. The primary center, Central Liquidator Clinic, which is situated in Kiev, is the administrative hub. A flow chart of the relationship of the various centers involved in the project is provided on page 9.

For the exclusive purpose of the UACOS a dedicated and fully equipped 600 ft^2 ophthalmological examination/imaging room, with an adjoining office, have been established in the Institute of Occupational Health (IOH) by the Director, Acad. Yuri Kundiev. In addition to conventional ophthalmic instrumentation (Slitlamp, direct and indirect ophthalmoscope etc.) it contains a fully upgraded Zeiss Scheimpflug Slitlamp Imaging System and Oxford Retro-illumination Camera. Acad. Nikolai Sergienko, Director of the Center for Eye Microsurgery (CEM) has assigned two of his staff ophthalmologists Drs. George Parkhomenko and Andre Ruban to oversee the facility. Both have been fully trained in radiation cataract assessment and lens imaging.

The ophthalmological facility is considered a satellite to the Central Liquidator Clinic which houses the dosimetry and registry efforts under the direction of Prof. Ilia Likhtaryov of the Ukrainian Scientific Center for Radiation Medicine (USCRM). Prof. Likhtaryov has named Dr. Vadim Chumak of the USCRM to support the



cataract program. From the U.S. side overseeing issues regarding ocular dosimetry are Drs. Lynn Anspaugh of the Lawrence Livermore Laboratory and Andre Bouville of the NCI both of whom are intimately involved in Chernobyl dosimetry associated with a variety of tissues.

Two ophthalmologists from each of the sites will receive training and instruction (by Drs. Sergienko, Worgul, Medvedovsky, Parkhomenko and Ruban on the standardized examination to be employed (see pages 28-32). On average each center will be responsible for the processing of ~1700 patients. Each Liquidator will be examined every 24 months. Assuming 200 work-days per year, on average, slightly more than 4 subjects will be examined per day per site. Thus by the conclusion of the first year's follow-up 6000 of the cohorts will have had their initial ophthalmic assessment.

The examination results, recorded on scan forms, will be available to the participants in the study - the forms will be transmitted to Drs. Parkhomenko and Ruban at the CEM who, after checking them for compliance, will retain the Ukrainian top sheets and forward the English second sheets to the ERERL. The sheets will be coded so that the identity of the individuals will not be known to the American arm of the study (see forms Appendices II & III, pages 62-73). Acad. Kundiev and Dr. Vitte of the Institute of Occupational Health (IOH) will independently supply the results of the diet and habits survey, again coded to guarantee privacy of the Liquidators enrolled in the study. Prof. Likhtaryov and Dr. Chumak will transmit the data on the eye-dose. The data will be jointly analyzed and statistically evaluated by the UACOS members.

The overall study is an integration of three key areas each with its own rationales, criteria and protocols.

I. Dosimetry support
II. Epidemiologic study design
III. Ophthalmic follow-up

I. DOSIMETRY SUPPORT PROTOCOL

Management and Oversight Personnel (Pages for biographical data in parentheses)

Ilia Likhtaryov, Ph.D. - P.I.	(Pages 43-44)
Lynn Anspaugh, Ph.D.	(Pages 36-37)
Andre Bouville, Ph.D.	(Pages 38-39)
Vadim Chumak, Ph.D.	(Page 40)

As illustrated in the organizational chart on Page 9, Prof. Ilia Likhtaryov Head of the Radiation Dosimetry Department of the Ukrainian Scientific Center for Radiation Medicine (USCRM) oversees the registry and retrospective dosimetry associated with the Liquidator follow-up. He and members of his group, including Dr. Chumak who is assigned specifically to our study, and **Drs. Lynn Anspaugh** of the Lawrence Livermore Laboratory and **Andre Bouville** of the NCI will oversee the dosimetric aspects. The work will parallel, and frequently complement, other, on-going, dosimetry efforts associated with the Liquidator population.

Although the total number of Liquidators exceeds 250,000 we will draw our sample from the 130,000 who served from April 26, 1986 through February, 1987. The rationale for this selectivity rests on the fact that the dose distribution tends more towards the higher levels than is found to be the case for the Liquidators who came later. An explanation for the difference in exposure lies in the fact that until February, 1987 the workers were permitted to receive the accident dose limit of 25 cSv (see below) thereafter the permissible exposure was reduced to 10 and later 5 cSv.

Personal Dosimetry At Time of Exposure: Personal dosimetry began on May 9, 1986, two weeks after the Chernobyl accident, and continues today. During the period of the most intensive and extensive activities at the reactor site, a host of institutions were involved in the dosimetry effort. Of these, the most significant data arrays were obtained by the Department of Dosimetric Monitoring of the Research and Industrial Association, "Pripyat", the Department of Radiation Protection of the Chernobyl Nuclear Power Plant, and the Armed Forces.

Unfortunately, personal dosimetry monitoring very soon after the accident (from the first hours until the 14th day) was not undertaken. That period was characterized by the overexposure of personnel due to the lack of dose-rate data as well as poor organization of the on-site activities. In addition, some data related to the period July-August, 1986, was lost. Dosimetric assessment of **all** the workers entering the 30 km zone was only instituted in 1987.

Of the **April, 1986 - February, 1987** Liquidators, approximately 130,000 live in the territory of the Ukraine. Of those about 22% have had direct measurements of dose. Throughout the early, radiation intense, period, the skills and conscientiousness of those responsible for the dosimetric assessment varied significantly. In some cases the results of the dosimetry were distorted intentionally. An early effort to determine the dose-distribution resulted in a bimodal curve with peaks at 120 mSv and 250 mSv.

The second peak in this distribution, the so-called "administrative maximum", is the result of two limiting factors. One was the existence of a 25 rem "accident limit" in force until February 1986. Another was a strict policy of not recording the fact that the 25 rem limit was exceeded. Analyses of all the available direct measured dose data, the distribution curve for the 1986-1987 population has a single peak at ~170 mSv.

For the above reasons, the existing official dosimetric records have, at best, only nominal utility for the purposes of this project. Therefore, it is essential that all the data from the 130,000 cases in the National Registry which provide dose estimates (thus far approximately 29,000 records have been transferred to the USCRM registry) be carefully analyzed to reject the wittingly false information, provide quality assessment, and filter the data available for epidemiological evaluation. We are approaching the dose reconstruction in two ways, using an analytical technique to estimate exposure and an instrumental method to measure it.

Analytical Reconstruction of the External Exposure Doses: Analytical dose reconstruction for the Liquidator cohort is based on the compilation and collation of three components: the work regime (environment and tasks), professional route data for each individual, and the results of the dose-rate measurements taken in the corresponding locations.

The source of the route data, the "Liquidator *Route List*" adheres to a specific format, requires corroboration by witnesses, and confirmation by on-site authorities (those responsible for the work of the Liquidators in question). In addition, each *Route List* is verified by knowledgeable individuals who are extremely familiar with the topography of the reactor site, profile of the recovery activities, and dose-rate data at the work sites and travel routes.

The direct measurements of the external dose-rate, β-contamination, and radionuclide composition, in more than 4,000 rooms of the Chernobyl Nuclear Power Plant (NPP) and points around the site, constitute the second critical component of the analytical retrospective dosimetry database. Analysis of these data indicate that perhaps the most important feature of the contamination pattern in the NPP site was a significant heterogeneity of the fallout and, consequently, dose-rates.

The non-uniformity of the contamination underscores the need to obtain highly accurate and extremely detailed route data from the individuals who are polled. This is becoming increasingly more difficult with the passage of time, and particularly now, that eight years have elapsed. Therefore, the analyses require the application of the theory of fuzzy sets rather than using deterministic dose values. Probabilistic mathematical approaches allow one to derive the most likely dose bracketed by its upper limit (maximum possible dose) for a particular *Route List*.

In arriving at a dose estimate, the *Route List* is divided into several "episodes" collectively describing the complete scenario of the occupational activity associated with the accident. Each episode consists of number of "frames", corresponding to those periods of activity when the exposure rate and γ/β dose ratio can be treated as constants. For each frame the assessments of the most probable and maximum absorbed doses are determined. The total dose is then calculated by the superimposing of doses from frames according to the rules governing fuzzy sets algebra.

Although this method is extremely time consuming and not readily approachable by algorithm, the exposure levels thus far determined by this approach coincide well with results of independent methods (e.g., personal dosimetry and/or the electron spin resonance technique). An example of the results of the analytical retrospective dosimetry are summarized in Table 2 (page 18).

Instrumental Reconstruction of External Doses: One of the most reliable methods of instrumental retrospective dosimetry of individuals is Electron Spin Resonance (ESR) spectrometry utilizing tooth enamel as the subject material. It is well known that irradiation initiates paramagnetic centers in the crystalline structure of enamel. The concentration of the centers depends linearly on dose. Figure 1 illustrates typical ESR spectra of irradiated and non-irradiated tooth enamel. These centers are extremely stable (up to 10^9 years) making enamel a highly attractive material for use as a retrospective dosimeter. Presently the minimum detectable dose threshold lies between 0.15 and 0.25 Gy. The broad background ESR signal (Fig. 1a, curve B) caused by the organic component of tooth enamel makes detection at lower doses difficult. However, the signal to background ratio can be improved by treating the samples to remove organics from the enamel.

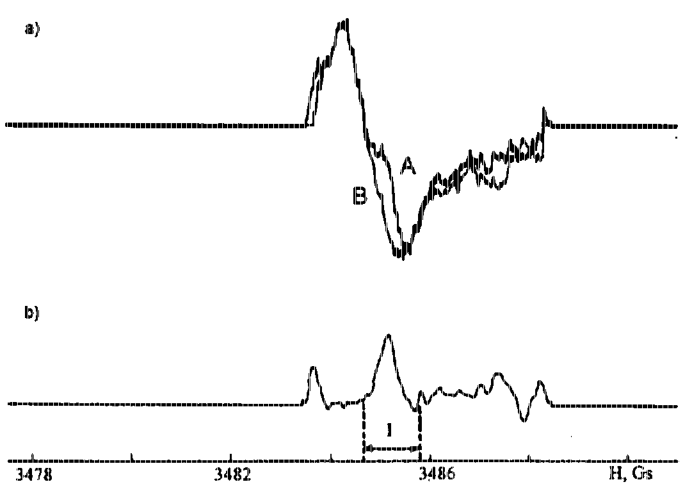


Figure 1: ESR-spectra of tooth enamel.

(a) A. ESR signature of a tooth irradiated with 0.25 Gy X-rays.
B. Signal from the same tooth (background signal) prior to irradiation.

(b) Result of subtracting spectra A and B.
I defines the radiation induced ESR signal from the CO_3^{3-} center.

The ESR technique for retrospective dose reconstruction requires a number of analytical steps. As shown in Figure 2 there are two procedures which can yield useful data. The complexity and labor intensiveness of each are directly related to its precision.

Full-scale method	Abbreviated-method
1. Patient registration	1. Patient registration
2. Assessment of the external dose by means of a survey	2. Assessment of the external dose by means of a survey
3. Dental examination	3. Dental examination
4. Tooth extraction	4. Tooth extraction
5. Preliminary treatment of tooth	5. Preliminary treatment of tooth
6. Washing	6. Washing
7. Crushing	7. Removing dentine by dental steel drill
8. Separating grains of appropriate size	8. Crushing
9. Separating the enamel and dentine by specific weight	9. Distributing and preparing the sample
10. Doping the ESR standard marker	10. Recording of ESR spectrum
11. Preparing the standard sample	11. Deconvoluting the spectrum
12. Recording the ESR spectrum	12. Determining the dose
13. Secondary controlled irradiation and recording the ESR spectra	
14. Deconvoluting the spectra	
15. Plotting individual calibration curves	
16. Determining the dose	

Figure 2: The steps associated with the ESR-dosimetry technique (Full-scale and Abbreviated Methods)

The critical steps areas follows:

1. Separation of dentine and enamel - two tooth components with different dosimetric and spectroscopic properties - is done mechanically or by exploiting the difference in specific weight.
2. Crushing the sample is necessary to obtain grains of optimal size for measurement.
3. Chemical treatment removes potentially quenching organic substances from the tooth enamel.
4. ESR measurements are then done on the pulverized material.
5. A series of the additional irradiations under controlled laboratory conditions provide individual calibration curves and thereby allow for differences in sample radiosensitivity.
6. Mathematical processing which includes deconvolution of the ESR spectra, taking into account the contribution of the background (natural) exposure etc.

The possible contribution from diagnostic x-ray exposure was modelled utilizing a dental x-ray facility. It was found that the dose differential between the outer tooth face and the inner surface was greatest for the molars (teeth #4+) and bicuspids (#3) and insignificant for the front teeth (#1 and 2). Therefore, if we recover #3 (or higher) teeth the inner and outer surfaces are processed separately to determine the diagnostic dose contribution. If teeth #1 or 2 are involved we must depend on the information in the tooth ID Form (see Appendix I, pages 59-61) for the number of examinations which the Liquidator has had.

The methodology is extremely labor intensive requiring 2-4 days to complete. However, the accuracy and reliability of the results readily justify the use of this method for the instrumental verification of analytical dose assessments and for the dosimetric support of defined contingents, as in this study, for which dosimetry is critical.

Conversion From *"Whole Body"* to *"Lens"* External γ-radiation Exposure: The dose to the lens of the eye is estimated from whole body doses (effective doses), or the doses obtained by a personal dosimeter usually held at chest level. In those case of a uniform frontal exposure, the dose to eye lens is considered to be equivalent to that determined by either approach. However, in the complex γ-radiation fields found in, and around, Chernobyl, the dose to the lens may differ from the measured or estimated whole body dose. Thus a correction factor must be applied to the existing dosimetric evaluations. Quantitatively this factor may be derived by Monte Carlo simulation with the application of an anthropomorphic mathematical phantom using assumptions regarding varying geometries and energy spectra of the radiation. These calculations must necessarily focus on the geometries most characteristic of the Chernobyl conditions (uniformly contaminated surfaces, surrounding geometry with varying activities in different sectors, sources of high activity on a low activity background, etc.). The assumptions regarding energy spectra consider the time which had elapsed since the accident in order to account for changes in the isotope composition caused by the decay of short lived radionuclides. If available, γ-spectroscopy data will be used for the verification of model assumptions and estimates. Derived transfer factors "whole body dose" - "dose to eye lens" will be computed with uncertainty ranges. The relative appropriateness of these conversion factors will be obvious from the comparisons of the extreme values of the doses derived from these factors to expected uncertainties of estimates or measurements of the whole body doses.

Estimating the Contribution of External β-exposure to the Lens Dose: The lens is one of the tissues for which the external β-exposure during the Chernobyl accident might make a significant contribution to the total dose. As is the case for complex γ fields, the β-dose to lens can be estimated by Monte Carlo simulation using realistic assumptions concerning irradiation geometries and radionuclide composition of the fission products released from the destroyed reactor. Due to rather strong attenuation in air, the exposure configuration is even more critical than is case for γ-exposure. The orientation of contaminated surfaces as well as effective area of radioactive "hot" spots must rolled into the Monte Carlo simulation.

Since the direct measurements of β-contamination and β-fluences at work-sites were not, as a rule, performed, the best of assessing the external β-radiation exposure to lens is to establish the correlation with the external γ-ray dose. Preliminary studies indicate that the energies of β-component (Fig. 3) as well as intensity of the irradiation (Fig. 4) changed in a complicated manner with time.

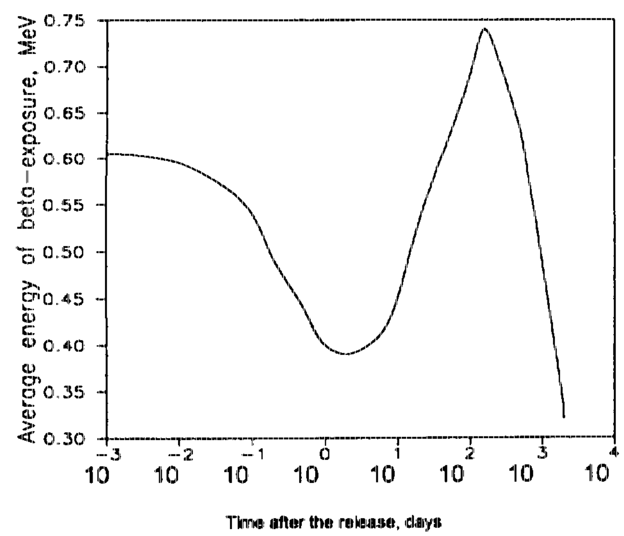


Figure 3: Average energy of the β-exposure from Chernobyl Reactor 4 fission products as a function of time after the release

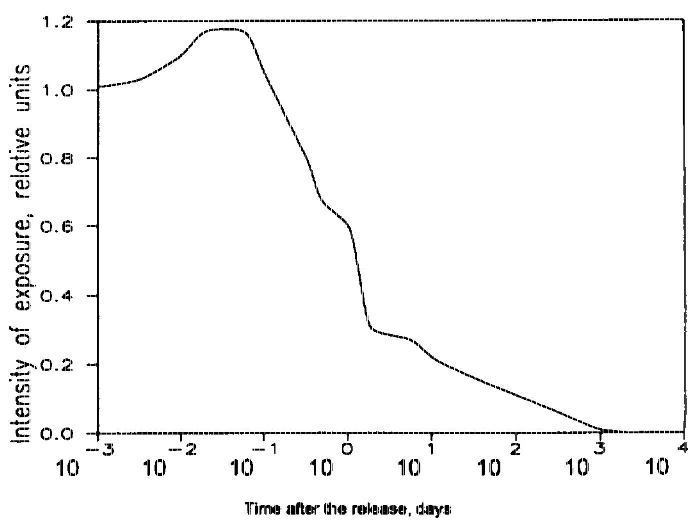


Figure 4 Intensity of the β-radiation from Chernobyl Reactor 4 fission products as a function of the time after release

Conversion factors will necessarily incorporate both the geometry of the irradiation and the time after the accident (to account for radionuclide composition). Table 1, page 15, contains preliminary maximum (β_{max}) β/γ ratios for the lens of the eye calculated using a cylindrical tissue-equivalent phantom for a series of times (radionuclide compositions) and effective source areas. The estimates which we will eventually use will be refined to account for behavioral considerations, for example whether or not spectacles or protective goggles were worn.

Table 1: Values of the β_{max} for the Lens at Different Times After Release

Effective area of the source (m^2)	Time after the accident								
	1h	*6h*	*1d*	*5d*	*15d*	*30d*	*60d*	*120d*	*360d*
2	3.1	2.4	1.9	2.7	3.9	5.3	6.5	10.0	18.3
3	3.4	2.7	2.2	3.0	4.4	6.0	7.4	11.2	20.6
5	3.0	2.8	1.9	2.6	3.9	5.5	6.5	10.0	18.2
8	2.4	2.0	1.5	2.0	3.1	2.4	5.2	7.9	14.5
12	2.0	1.7	1.3	1.7	2.6	2.0	4.3	6.6	12.0
18	1.7	1.4	1.1	1.4	2.2	1.7	3.6	5.6	10.2
25	1.4	1.2	0.9	1.2	1.9	1.4	3.1	4.8	8.8
35	1.3	1.1	0.8	1.1	1.7	1.3	2.9	4.4	8.1
45	1.2	1.0	0.8	1.1	1.6	1.2	2.6	4.0	7.4

The results of the refined calculations will be entered into a lookup table providing for the dependence on time, geometry and special circumstances (e.g., goggles). Confidence intervals for the conversion factors (such as those arising from the uncertainty of input data) will be included in the tabulation.

In addition, in concert with β-contamination measurements and the results of γ-spectrometry of the fallout, the classification of the work-sites and the nature of the activities of the workers will be generated. Characteristic class-dependent conversion factors can then be estimated as well. In this way a more precise assessment of the external β-dose contribution can be achieved. Furthermore, depending on the scope of the data, individualized assessments may reduce the uncertainty even further.

Assessment of the Internal Exposure Dose Contribution to the Lens Dose: It is well established, that because of the circumstances of the Chernobyl accident cleanup, the internal exposure represented a significantly smaller contribution to the total dose of the Liquidators than did the external exposure. Consequently, the contribution of the internal exposure to the lens dose is believed to be negligible. However, a targeted investigation is planned to determine the validity of this view. The doses contributed by different radionuclides deposited in soft and hard tissues will be calculated. These calculations (using worst-case assumptions concerning radionuclide intake during the recovery activities) will involve metabolic models together with Monte Carlo simulations employing the anthropomorphic mathematical phantoms. The maximum lens doses which, conceivably, can be caused by internal sources will be compared to the doses of the external γ- and β-ray exposures; the derived assessments will then be compared with dose uncertainties from the dominant sources.

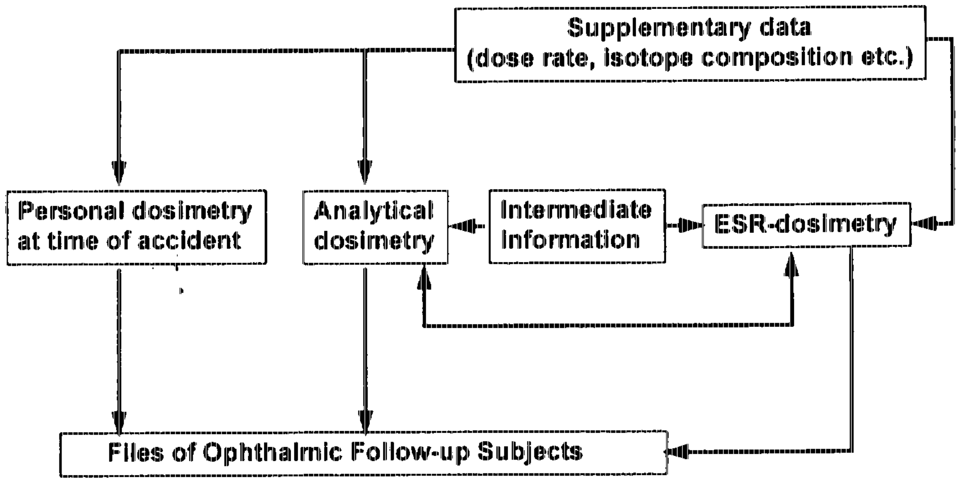
Data Handling: We propose to bank all the individual dosimetry data for the workers enrolled in the present investigation in the special dosimetric register comprising several computer data bases. The data are maintained in the dBase III format to allow ready processing, analysis and exchange. Several classes of data are represented in these data bases:

1. The results of personal dosimetry at the time of accident (obtained from those who currently hold this information - if needed, protocols will be designed to transform records from data bases in foreign formats).
2. The results of the analytical dose reconstruction.
3. The results of the instrumental retrospective dosimetry.

4. Intermediate information such as *Route Lists*, tooth identification forms (raw data of the ESR assays) etc. will be formalized and entered into a data base.
5. Supplementary data such as dose-rates, isotope composition in different locations etc.
6. A computer file for every worker in the ophthalmic follow up - the central element of the dosimetric register. The file will contain excerpts of dose records (including uncertainty estimates) as well as the complete histories of the participants in the Chernobyl clean-up and administrative data including contact addresses and telephone numbers.

The overall structure and interrelations between elements of the data base family are shown in Fig. 5. All the data bases are to be linked by a universal identifier thereby allowing joint processing and analysis.

Figure 5: Structure of the data base and data handling relevant to the dosimetry for the ophthalmic follow-up.



Bioprobe Bank.: A bank of biological probes consisting of teeth from Liquidators provided to our faculty has been established. This bank is comprised of three sections repositing bioprobes at various levels of processing: primary materials (unprocessed whole teeth or portions), initially processed samples and archival storage.

Upon arrival, teeth which were transported while preserved in a special medium (Nikiforov's cocktail), are cleaned to remove any remaining soft tissue. They are then dried and stored as untreated samples in the primary materials section of the bioprobe bank.

After the initial processing of the samples (cutting the tooth root, removal of dentine, crushing) the pulverized samples are used for dosimetric screening by an Abbreviated ESR-dosimetric method. They are then stored as initially processed samples.

If selected for further work, particular samples are subjected to more rigorous assay. They are treated chemically and thermally to maximize accuracy and increase the sensitivity of the detection, thereby lowering the dose limit of the reconstruction. After a series of controlled irradiations and ESR measurements, the samples are reposited for long-term sequestering in the archive storage section of the bank.

At all stages of storage, bioprobes are kept in individual containers with clear labeling to minimize the chance of loss or mix up. All relevant documentation including ID codes are entered into a computer data base and concomitantly archived as hard copies. The status of the bioprobes at any given time is registered in a special log as well as in the computer files. Since the bioprobes are extremely compact, a nearly unlimited number of samples can be without undo effort or special requirements except to protect them from additional radiation exposure (over the natural background level).

Providing Access to the Personal Dosimetry Records.: At present, personal dosimetry records are stored in the national registry of individuals who suffered from the Chernobyl accident (most of it data from 1986) as well as in the registries of the Department of Dosimetric Monitoring of the Research and Industrial Association "Pripyat" and Department of Radiation Protection of the Chernobyl Nuclear Power Plant. Ongoing acquisition of this data is provided within the framework of bilateral agreements between the USCRM and each of the agencies maintaining it. The information is typically transferred by printed or digital media.

Acquisition of Tooth Samples From the Liquidators.: Currently, the teeth are extracted from Liquidators at two centers - the Hospital of Liquidators in Kiev (Liquidators of Kiev city and Kiev region) and Special Hospital #126 in Slavutich (a satellite town to the NPP). By agreements with these hospitals dentists collect, and ship to us for study, all teeth from persons who belong to the group of Liquidators in which we are interested, the participants of Chernobyl clean-up in 1986-1987. Tooth samples are accompanied by *"Tooth ID Forms"* - reflecting the individual history of contact with radiation (during the work in Chernobyl and during the non-accident related lifetime) as well as personal data and subjective recollection (see Appendix 1, pages 59-61).

We are in the process of extending the tooth sample acquisition network to all hospitals responsible for the medical care of the Liquidators. This network, with assistance of local health protection agencies, will consist of the dental departments of the associated hospitals in close communication with the methodological center in the Department of Dosimetry of the USCRM. The USCRM will be responsible for all the bioprobe registrations, longitudinal storage, and *Tooth ID Form* data entry into the database.

Practical Dose Reconstruction: The principal criterion for the selection of subjects of the cohort is the existence of reliable data on the external γ-exposure during the clean-up activities. The sources of this data will be:

1. Official personal dosimetry records which were generated by those whose expertise provide a high reliability of the validity of the data.
2. Results of analytical dose reconstruction (with *Route List*) according to a standardized method.
3. Instrumental retrospective dosimetry by means of ESR-spectroscopy of tooth enamel.
4. If possible, corroborative biological dosimetry (only if confidence is high and it is possible to differentiate external and internal exposure in the post-accident period).

The next step will be to convert the whole body (personal dosimeter) dose to the lens dose and estimate the contribution of external β-irradiation to the latter. This will involve a series of Monte Carlo calculations using anthropomorphic phantoms with respect to different irradiation conditions. All patients will be surveyed in order to get information about the duration and spatial aspects of the Chernobyl recovery activities.

In order to optimize the studied cohort with individual dose determinations of high confidence, the strategy is as follows:

1. Evaluate the credibility of the official personal dosimetry records in order to select reliable data from this array. This will involve (a) correlating the officially recorded doses with the levels thought to be present when the activities were being performed, (b) cross referencing and checking data for individuals who were working in similar conditions during the same period and on whom personal dosimetry was conducted, and, (c) determining the departmental affiliation of the Liquidator. In the event that the official records do not cover the entire period of work in the Chernobyl area, the available data will be taken into account, but the final conclusion concerning dose ultimately will be dependent on the results of the retrospective dose reconstruction.

2. Conduct an analytical retrospective dosimetry of the 1986-1987 Liquidators, primarily for the on-site workers. These calculations depend on two sets of data. One is the result of direct dose-rate measurements in more than 4,000 rooms and reference points at the NPP site and the other, is derived from information gleaned from the *Route Lists* detailing worker locations and working conditions. Exploiting the theory of fuzzy sets, the maximum possible, and the most probable, doses will be

calculated. These dose assessments are already completed for approximately 1,400 Liquidators; *Route Lists* for more than 3,000 Liquidators are currently available for calculation. It is anticipated that 12,000 dose assessments will be completed within the next two to five years.

3. Undertake ESR-dosimetry using tooth enamel as a natural dosimeter. We presently have a method which allows us to reconstruct doses higher than 0.2 Gy within 25% accuracy. Our bioprobe bank, which is growing daily, currently contains over 350 teeth which were extracted from Liquidators. Every sample is accompanied by a tooth identification form (see Appendix I, page 59-61) containing personal and contact data as well a lifetime history of radiation exposure including medical and dental. Currently, we are developing a nationwide network for sample acquisition.

ESR-dosimetry is extremely labor intensive and, therefore, 100% coverage of Liquidators with this method is impossible in the short term. Therefore, we are approaching the ESR assessment, the most accurate and reliable tool for retrospective dosimetry, in two ways.

First, it will be used for selective verification of doses derived from official records and the analytical retrospective dosimetry. Secondly, individuals with doses higher than 0.25-0.3 Gy, as measured using the abbreviated ESR analysis, may be included in the cohort with detailed dose reconstruction performed within the next 2-5 years.

Information about all individuals included into the investigation will be entered into our data base for storage and further processing. Permanent contact with this cohort will continue not only for purposes of periodic ophthalmic examinations, but also for additional surveys aimed at improving the accuracy of the dose estimates.

The calculation of γ- and β-doses to the eye lens will require considerable effort and investment, although some studies designed specifically to estimate the β/γ ratio in the lens have already been initiated (see Table 1, page 14). Monte Carlo simulations using existing, as well as specially designed, mathematical anthropomorphic phantoms will be used for this purpose. The calculations will be performed for different irradiation geometries and energy (radionuclide) compositions of the exposure. The use of protective goggles or other eyewear will be considered as well. The results of these calculations will be available in tabular format, classified according to the time after the release, and configuration of work places. The sources of error propagation and uncertainty assessments will also be included in this model.

The dosimetric support for the cohort study will ultimately result in an array of individual lens doses for every participant in the follow-up as well as the assessment of the uncertainty of the dose for each Liquidator. Current (rough) estimates for the uncertainties which accompany the doses determined by the instrumental and analytical methods are 30% (at 15 - 20 cGy) and 40-60% respectively. The bases for these rough estimates are given below[1]. It is important to recognize that while we anticipate a range of confidences, for the purposes of our evaluation and given the doses with which we are concerned (particularly for addressing the deterministic/stochastic issue for radiation cataract), uncertainties twice those estimated should not impact the conclusions greatly. Such uncertainties in the evaluation of absolute risk are similarly unlikely to be problematic. This is because established doses will be bracketed as will the risk values to which they give rise.

The highest probability of radiation cataracts is for those individuals exceeding doses of 25 cSv. Therefore, that group of individuals have been the initial focus of the retrospective dosimetry effort as it relates to the cataract investigations. Estimating that 5-15% of the 130,000 1986-1987 Liquidators fall into this

[1] The error for the ESR technique includes instrument error and the error for the dose value which, in turn, is determined from a calibration curve with its own intrinsic error. The possible error in the assigned dose is derived by Monte Carlo sampling from the error distributions. In the case of the analytic dose reconstruction, the fuzzy sets technique provides an assessment of mean dose and maximum, possible dose. These values are related by a conversion factor which primarily depends on the time which has elapsed since the accident. By assuming that the factor corresponds to an upper 2 sigma confidence interval and that the distribution is lognormal one calculates a 40-60% uncertainty for this technique.

category, we project a potential pool of 6,000 - 20,000 people with exposures greater than 250 mSv. Given the fact that this population is already being so closely scrutinized and because its dose distribution is such that it favors the higher doses we plan to focus our effort on this group.

Table 2 , below, provides a breakdown of age and dose for a group of 1197 Liquidators who have had confirmatory dosimetry as of May, 1993. This list, which now numbers 3000, illustrates the nature of the population which is available. Clearly this represents an opportunity unparalleled in the history of radiation risk assessment to fully define a modality of considerable potential for monitoring the well being of our populace.

Table 2. Age and dose distribution for 1197 Liquidators (1% of the total population in question) who had worked near or inside Reactor 4 during May - June 1986 and whose doses were confirmed by follow-up retrospective dosimetry (Provided by I. Likhtaryov).

Number of Subjects							
Age (years)	Dose (cGy)						
	< 5	5 -10	10 - 25	25 - 50	50- 100	>100	All
18-22	2	1	8	8	2	4	25
23-30	1	4	22	42	56	22	147
31-40	4	10	44	116	146	70	390
40-55	8	22	80	184	208	112	614
>55	1	1	6	6	6	1	21
TOTALS	16	38	160	356	418	209	1197

It must be emphasized that these initial individuals were selected because of the high dose nature of their exposures. Therefore, this is not a random distribution. The skewing to the higher doses and older individuals is also not fortuitous. Those with supervisory responsibilities tended to be older and, because of their roles, were more likely to remain, on-site, for longer periods. In any case, the numbers which can be generated, are clearly apparent. By initially drawing from this pool and specifically targeting those not retrospectively assessed, but who are in enrolled in the eye cohort, we are confident that retrospective analysis will be completed on the entire cohort by the end of the second examination cycle.

II. EPIDEMIOLOGIC STUDY DESIGN AND PROTOCOL

Management and Oversight Personnel (Pages for biographical data in parentheses)

Roy Shore, Ph.D. - P.I.	(Pages 49-50)
Yuri Kundiev, Ph.D. - Co P.I..	(Pages 41-42)
Peter Vitte, Ph.D.	(Page 53)

The study design is basically a cohort study in which the subjects have a broad range of doses to the eye (from <5 to >100 cGy). Although the average dose to the entire Liquidator worker population is only 15 - 20 cGy, because the population is large we can oversample the medium and high dose ranges to produce a dose distribution that yields maximal statistical power to answer the scientific questions that we have posed. In order to obtain more detailed information on risk factors for cataracts, we will supplement the cohort study with a nested case-control study, in which a more extensive questionnaire will be administered to cataract cases and a set of matched controls.

Expected Risk of Cataract Induction: Based both on animal data (see Worgul et al., 1993) and preliminary indications in available human data (Otake et al., 1992; Klein et al., 1993) we posit that the radiation induction of cataracts is a stochastic process, which implies that even low to moderate doses will confer some measure of added risk. In order to estimate the likely magnitude of risk, we obtained preliminary data from Dr. Vasily Gaiday who has examined 120 "high dose "Liquidators in the Ukraine over the last five years (i.e., about 2-7 years post exposure) The examination techniques were not as sensitive as we will employ, so his numbers undoubtedly represent a lower bound on risk. The resulting data are shown in Table 3. The apparent absence of risk in the lowest dose group is likely to result from a combination of (1) the small number of persons examined, (2) the limited sensitivity of the examination procedure (see Table 3 footnote), (3) the fact that these examinations were performed within a few years after the radiation exposure and unfortunately he did not indicate when during the five years the individual observations were made. The last point is extremely relevant in that it is well documented that the time to cataract formation (latent period) is inversely related to dose.

Table 3. Preliminary Data for Cataractogenesis in 120 "High Dose" Liquidators
(Personal Communication, Vasily Gaiday)

Dose	n	Cataract	Non-cataract
1-2 Gy	59	0	59
2-4 Gy	45	8	37
> 4 Gy	16	6	10

It should be noted that the data are intrinsically anecdotal. Also, they are derived from observations spread out over the last five years. In addition, some of the cataracts were assessed grossly with an ophthalmoscope. Therefore, the numbers are surely an underestimation of the individuals with early to moderate cataracts.

The average absolute risk in Table 3, calculated as a weighted average across the three dose groups, is about 5% per Gray (or 5×10^{-4} cGy^{-1}). This corresponds well with the absolute excess risk estimate of about 4.6% per Gray for the gamma dose found in the Japanese A-bomb study (Otake and Schull, 1990).

Dose Distribution and Selection of Study Subjects

Since the previous version of our proposal, we have found it necessary to shift from an annual examination to a biennial one, since 10,000 subjects could not be examined each year. However, this change will permit an increase in the sample size somewhat at the low-dose level so that there are 12,000 subjects in all rather than 10,000. Thus half the cohort will be examined per year. The new projected dose distribution is shown in Table 4 (the previous numbers of subjects were 2,000 at <5 cGy and 500 at 5-10 cGy).

Table 4. The distribution of doses that the study would aim for and that which was used in the simulation to evaluate statistical power.

Dose Range (cGy)	Assumed Mean Dose (cGy)*	Assumed Percent Distribution	Distribution of Workers for N=12,000**
< 5	2.5	20.8	2,500
5 - 10	7.5	16.7	2,000
10 - 25	17.5	16.7	2,000
25 - 50	37.5	25	3,000
50 - 100	73.0	14.6	1,750
> 100	130.0	6.3	750

* When just the dose range 0-70 cGy was considered, only half the subjects in the 50-100 cGy dose interval were used and the estimated mean dose assigned to them was 60 cGy.

** Originally we had for perceived logistical reasons used an N of 10,000 but because of a change in the examination cycle there is less constraint on the sample size so that the <10 cGy groups could be effectively increased. Although the risk coefficient calculations remain based on the 10,000 cohort, if they are affected it will be to only make them more conservative.

. The rationales for this dose distribution of persons are as follows:

- 1) In order to have good statistical power and a good estimate of the risk at high doses, one needs a fair representation of high-dose (i.e., >70 cGy) persons. However, the number of high-dose persons is limited-about 2,600 with doses >70 cGy among the 130,000 liquidators-so our selection is limited by that number.

- 2) The main concern of the study is the risk among those with low to moderate doses, so we clearly want substantial numbers in the range of 10-70 cGy. At doses below 10 cGy a large number of subjects is required to see an effect especially if the dose-response function is linear-quadratic._In particular, we want to determine whether a dose-response trend can be seen over the range of 0-70 cGy, and to have reasonable power and precision in estimating the linearity/curvilinearity of the dose-response function.

- 3) An adequate baseline rate of cataracts among persons with equivalent intensity of screening is also needed as an anchor to the curve. To this end, a pool of Liquidator subjects with little or no exposure will be included. Our projected sampling of workers by dose range represents an attempt to balance these three competing goals. The percents shown in Table 4 were applied to each of the sample sizes we evaluated: 5,000, 10,000 and 15,000.

Assessment of Statistical Power and the Required Sample Size

As noted above, we have changed the sample size to 12,000 subjects (from 10,000 in the previous version of the proposal). This will increase the statistical power and precision of the study somewhat over the results we presented previously, but because of the extensive calculations involved we have not performed new calculations. The results given below should therefore be regarded as a **lower bound** on the statistical power and precision that we should be able to achieve with the enlarged study population size

The preliminary study of the magnitude of radiation cataractogenesis among Chernobyl liquidators yielded an estimate of 0.0005 per person per cGy within seven years of the accident (see page 20). To be conservative we assume that the excess prevalence of 0.0005 per person per cGy would occur in 10 years i.e., that the excess is 0.005 per person-year per Gy [0.005 $(PY \cdot Gy)^{-1}$]. Given that our examination techniques will be more sensitive than those used with the preliminary data, we expect that the absolute excess risk will be higher. Nevertheless, to evaluate statistical power, we have used the estimate of 0.005 $(PY \cdot Gy)^{-1}$, plus values which bracket this estimate, namely, 0.01 $(PY \cdot Gy)^{-1}$ and 0.002 $(PY \cdot Gy)^{-1}$, in order to cover a plausible range of possible outcomes. Experimental studies by the present authors (see Worgul et al., 1989; 1993; Brenner et al., 1991; 1993) have shown that the dose-response curve is usually linear-quadratic, with the low-dose risk typically a factor of 1.2 to 1.8 lower per unit dose than the high-dose part of the curve. So, to be conservative in modeling the expected cataract response, we built in a low-dose reduction factor of 2 for doses under 70 cGy (where 70 cGy was the estimated "dose threshold" or inflection point in the A-bomb study dose-response curve (Otake and Schull, 1990.).

From the time of the Chernobyl accident until the end of our proposed 5-year study represents 12 years of follow-up (or 11.8 years on average once sample attrition is factored in).[2] A 15-year study, as we anticipate, would represent a maximum follow-up of 22 years and an average follow-up of about 19.6 years after factoring in sample attrition while a 25 year study would provide up to 32 years of cataract documentation. These values were applied to the risk estimates (e.g., 19.6 yr x 0.005 $(PY \cdot Gy)^{-1}$) in modeling the radiation risk. We applied the risk estimates to 5,000, 10,000 or 15,000 persons, using the dose distributions shown in the original version of Table 4. The assumptions and procedures for estimating the spontaneous prevalence and incidence of PSCs and for other aspects of the model are given on Pages 26-27.

The statistical power calculations were performed using an adaptation of a method proposed by Nam (1987) to estimate the required sample size for a dose-response function with a binary disease outcome. When considering the full dose range, we modeled a function in which those >70 cGy had the full coefficient of risk, while the risk for those below 70 cGy was 1/2 as large per unit dose. (For the dose interval 50-100 cGy (Table 4), we assumed that half the subjects were ≤70 and half were >70 cGy.) Since the range <70 cGy is of primary interest, we also estimated the statistical power for dose-response analyses limited to that dose range.

For the proposed 5-year study (i.e., for a total of 12+ years since exposure), a sample of the expected results from the simulation of the spontaneous and radiation-induced PSCs is given in Table 5, and the statistical power results are given in Table 6. The statistical power was good for analyses over the full dose range. In particular, if the radiation risk of PSC cataracts is in the range 0.005 to 0.01 $(PY \cdot Gy)^{-1}$, then the statistical power was >99% for all three sample sizes considered, *viz*., 5,000, 10,000 and 15,000. For a radiation risk of 0.002 $(PY \cdot Gy)^{-1}$ the statistical power was >95% for the two larger sample sizes, but fell to 74% for 5,000 subjects.

---

2 Sample attrition represents losses to follow-up caused by death, severe disability, out-migration, terminated participation, etc.

Table 5. The numbers of expected spontaneous and radiation induced cataracts by dose range for selected sample sizes, study lengths, and risk coefficients.

	5 Year Study						10 Year Study					
	N = 5,000			N = 10,000			N = 5,000			N = 10,000		
	Spont-aneous	Radiation Induced		Spont-aneous	Radiation Induced		Spont-aneous	Radiation Induced		Spont-aneous	Radiation Induced	
Dose Range (cGy)		Risk Coeff# 0.0005	Risk Coeff# 0.03		Risk Coeff# 0.005	Risk Coeff# 0.03		Risk Coeff# 0.005	Risk Coeff# 0.03		Risk Coeff# 0.005	Risk Coeff# 0.03
< 5*	34.0	0.9	5.3	67	1.8	11.0	61	1.5	8.8	122	2.9	18
5-10*	8.4	0.6	3.3	17	1.1	6.6	15	0.9	5.5	30	1.8	11
10-25*	34.0	5.1	31.0	67	10.0	62.0	61	8.6	52.0	122	17.0	103
25-50*	50.0	17.0	99.0	101	33.0	198.0	91	28.0	166.0	182	55.0	331
50-100*	29.0	25.0	150.0	59	50.0	300.0	53	42.0	251.0	106	84.0	501
> 100*	13.0	29.0	172.0	25	57.0	344.0	23	48.0	287.0	46	96.0	574
Total	168	77	461	335	154	922	304	128	769	608	256	1,538

The risk coefficients are absolute excess risk per person-year per Gy.

* For those under a dose of 70 cGy the risk coefficient applied was only one-half the nominal value to simulate a low-dose reduction factor of 2.

Table 6. Estimates of the statistical power dose-response analyses for a cataract cohort study, for various sample sizes, study lengths, and risk coefficients.

Cataract	5 Year Study			15 Year Study			25 Year Study		
Risk Coeff.#	N = 5,000	N = 10,000	N = 15,000	N = 5,000	N = 10,000	N = 15,000	N = 5,000	N = 10,000	N = 15,000
***FULL DOSE RANGE** **									
0.002 #	74	95	99	89	99	99	92	99	99
0.005 #	99	99	99	99	99	99	99	99	99
0.01 #	99	99	99	99	99	99	99	99	99
0.03 #	99	99	99	99	99	99	99	99	99
***DOSE ≤70 cGy** **									
0.002 #	17	30	42	24	43	59	26	46	63
0.005 #	65	91	98	83	98	99	87	99	99
0.01 #	98	99	99	99	99	99	99	99	99
0.03 #	99	99	99	99	99	99	99	99	99

The risk coefficients are absolute excess risk per person - year per Gy.

* Because a low dose reduction factor of 2 was incorporated, the risk coefficients for doses ≤70 cGy were actually half as large as the nominal ones stated here.

The statistical power for the dose range ≤70 cGy in the proposed study was variable (Table 6). (Note that the risks actually being modeled in these analyses were only half the nominal values, due to the low-dose reduction factor of 2). For all the sample sizes considered and all the lengths of study, the statistical power was good if the radiation risk was at least 0.005 $(PY{\cdot}Gy)^{-1}$, except for the a 5-year study with a risk of 0.005 $(PY{\cdot}Gy)^{-1}$. However, if the radiation risk coefficient is only 0.002 $(PY{\cdot}Gy)^{-1}$ (i.e., the projected risk with a low-dose reduction factor is only 0.001 $(PY\text{-}Gy)^{-1}$), then the statistical power over the dose range ≤70 cGy would not be adequate. It is noteworthy, however, that if the actual risk level is only slightly higher, namely, 0.002 $(PY{\cdot}Gy)^{-1}$ rather than 0.001 $(PY{\cdot}Gy)^{-1}$, then the statistical power with 10,000 subjects becomes more acceptable - 60% for a 5-year study or 79% for a 15-year study. By way of contrast, a 5,000 subject study does not reach acceptable levels of statistical power (35% and 50% for a 5-year or 15-year study respectively). This leads us to conclude that a sample size of 5,000 subjects is inadequate, and that the study should include at least 10,000 liquidators, so that, if the radiation risk at lower dose levels should prove to be as low as an excess of 0.002 per Gy per year, we still would have a reasonable prospect of detecting the risk.

Epidemiologic Questionnaire: As part of the overall Ukrainian effort, a complete personal history, including activities during and after their Chernobyl exposure as well as health and occupational information, is available on all subjects involved in the Chernobyl follow-up. In addition a risk factor questionnaire will be administered to the study subjects to obtain information on various types of exposures they may have had in the past. This questionnaire will be modeled after one used by the National Cancer Institute [Health Habits and History Questionnaire; Diet History and Other Risk Factors] which is currently being adapted to the culture (e.g., common foods) of Ukraine. An occupational history will be taken, as well as a list of types of exposures or industries in which certain genotoxic exposures are likely. The list will include exposures to organic solvents (e.g., benzene, trichloroethylene), tar or combustion derivatives (exposure to polycyclic aromatic hydrocarbons), ethylene oxide, etc. Information will be obtained on the amount of ultraviolet exposure (Hiller et al., 1983; Italian American Cataract Study Group, 1991), including both occupational and recreational. Smoking (Christen et al., 1992; Klein et al., 1992) and alcohol consumption (Ritter et al., 1993) will also be assessed. A dietary history instrument will be included, oriented toward assessing dietary (and diet supplements) of antioxidant micronutrients including Vitamin E, Vitamin C and carotenoids, as several studies have found these to be protective against cataracts (Italian American Cataract Study Group, 1991; Jacques and Chylack, 1991; Hankinson et al., 1992; Leske et al., 1992).

The questionnaire on lifestyle factors (smoking, alcohol, ultraviolet light (UV) exposure), medical exposures and dietary factors will be pilot tested and revised as needed. It is important to account for possible UV contributions to cataract development. Although most of the cohort will have similar UV histories the possibility of behavioral or occupational modulation of the median exposure will be addressed in the survey. As regards diet questionnaires used in other studies in the F.S.U. (e.g., by Dr. D. G. Zaridze, Russia) will be solicited as models, to help ensure that the principal foods are captured in the questionnaire. However, for the most part a culture-corrected version of the *Health Habits and History Questionnaire; Diet History and Other Risk Factors* (version 3) developed by the National Cancer Institute will be the backbone of the survey.

Because obtaining a thorough set on all these risk factors would take a great deal of interviewing time it is not feasible to do for all 12,000 study subjects. We, therefore, propose that we will administer an abbreviated questionnaire (e.g., only about 50 dietary items and a limited set of questions on U.V. and occupational exposures) to all subjects. We will then administer a more extensive questionnaire to subjects with Stage 1+ cataracts or greater and to a set of matched controls. Two time-matched controls will be selected per case matched on age and sex (Lubin and Gail, 1984; Robins et al., 1986). The dosimetric estimates will also be carefully examined for these subjects and refined as much as possible. The interviewers and dosimetrists doing the case control work will be blinded as to case control status, so as to prevent an inadvertent biasing of the data.

Quality Control and Study Management

The cohort study subjects will be group-matched on age across the dose range, so as to maximize the validity of the dose-response comparisons. Careful assessment will be made to exclude from enrollment those who suffer from one of a number of potent risk factors for cataracts which could complicate radiation cataract assessment. They fall under several categories:

Intraocular diseases:

Uveitis/inflammations, glaucoma, retinal detachment, retinal degenerations (retinitis pigmentosa, gyrate atrophy), persistent hyperplastic primary vitreous, aniridia, Peter's anomaly, sclerocornea, microphthalmia, Norrie's, retinoblastoma, Retrolental fibroplasia, high myopia, retinal anoxia (Buerger's, Takayasu's pulseless disease), anterior segment necrosis.

Systemic diseases:

a. Metabolic disorders:

Diabetes, galactosemia, hypoparathyroidism/hypocalcemia, Lowe's, Albright's, Wilson's, Fabry's, Refsum's, homocystinuria

b. Skin diseases:

Congenital ectodermal dysplasia, Werner's, Rothmunf-Thomson, atopic dermatitis

c. Connective tissue/skeletal disorders:

Myotonic dystrophy, Conradi's, bone dysplasias, dislocated lenses

d. Renal diseases:

Low's, Alport's

e. Central nervous system:

Marinesco's, Sjogren's bilateral acoustic neuroma (neurofibromatosis II)

Drugs:

Steroids, naphthalene, triparanol, ouabain, ergot, chlorpromazine, thallium, dinitrophenol, DMSO, psoralen, miotics, paradichlorobenzene, selenium.

If, one of these factors come into play during the course of the study, for example if a Liquidator develops diabetes, that individual will be carried along in the study, but will be flagged and may have to be analyzed as a separate stratum or deleted from selected analyses. Liquidators with some presenile or congenital lens changes which are not located in the PSC area or which do not interfere with visualization of that region, will not be disqualified from enrollment.

Every effort will be extended to keep the participation rate high in the study. Since the Liquidator clinics at which the examinations will be performed provide certain medical benefits, there should be incentive for them to continue their participation. We will carefully monitor the participation rates to prevent their varying by dose; if they do begin to do so, extra measures will be instituted to help equalize the rates.

A comprehensive plan for the management of the logistics and the data will be developed at the study outset. A computerized database will be developed to keep track of the addresses and most recent clinic visits of study subjects, so that reminders and other follow-up procedures can be instituted as needed. The results of the visual examinations will also be computerized. These databases will be maintained at the USCRM under the guidance of Prof. Likhtaryov and at the ERERL of Columbia University under the PI's supervision. Quality control procedures for data collection, coding and computerization will be put in place at the inception of the study. Data quality will be monitored by the Ukrainian team leaders and Dr.'s Wu and Medvedovsky of the ERERL.

As mentioned above, quality control procedures for the ophthalmological examinations, and especially for defining opacities, are of critical importance. To this end, initial training and periodic reexamination of a sample of subjects will be undertaken by Dr. Medvedovsky and/or Dr. Sergienko. As much as possible, examiners will be kept blinded as to the dose received by individual workers. A photo-slitlamp will be used to obtain photo-documentation of cases diagnosed as having posterior subcapsular opacities, as well as a representative sample of 10% of the subjects. This will permit re-scoring of the opacities using other standardized methods and will also enable us to assess false-positive and false-negative screening rates.

Statistical Methods

Preliminary analyses will be conducted to determine whether any of the lifestyle-medical-dietary variables are confounders of the radiation-cataract association. Any that are found to alter the association by at least 10% will be included as confounders in the analyses. The main analyses will evaluate the dose-response relation between radiation and cataract occurrence, controlling for age and any confounder variables. The analyses will use a Poisson regression approach similar to the one used to study cancer mortality/incidence in the Japanese A-bomb study (e.g. Shimizu et al., 1990; Thompson et al., 1993). However, since this study will obtain both prevalence and incidence data, the methods will be modified to accommodate this feature, as was done in the recent Utah screening study pertaining to radiation fallout and thyroid neoplasms (Stevens et al., 1992). Linear, rather than log linear, models will be used for modeling radiation effects, since the exponential relationship implied by a log linear model is not biologically plausible.

The shape of the dose-response curve will be evaluated. Two alternative hypotheses are that there is a dose threshold at about 70 cGy (as suggested by Otake and Schull 1990), which would imply a deterministic effect for cataract induction, or that there is no dose threshold and that the dose-response curve is essentially linear down to low doses, implying that radiation-induced cataract is a stochastic effect. A linear trend can be modelled using the mean dose in each dose group, while a threshold can be modelled by assigning zero to all dose groups below 70 cGy and the mean doses for each dose group 70 cGy. One way of comparing these is to determine which gives a better fit to the data (i.e., has the smaller deviance). Another approach that is sometimes illuminating is to fit the linear function and the threshold function separately, then to fit both functions together. By comparing the difference in deviances for the nested models one can thereby determine whether the linear function accounts for significant deviance above and beyond the threshold function and vice versa. If, for instance the addition of a linear function to the threshold function provides a significantly better fit than the threshold function alone, this would be persuasive evidence for a non-threshold model. Or, if the opposite were true, it would be persuasive evidence for a threshold model.

ASSUMPTIONS AND METHODS FOR THE ANALYSIS OF STATISTICAL POWER

In order to have a realistic model of the expected frequency of "spontaneous" cataracts, several parameters need to be estimated: the prevalence and incidence of spontaneous cataracts at various ages,, the age distribution of the liquidators at the time of exposure, the losses-to-follow-up over time, and the resulting person-years-at-risk staged over time according to age. Analyses will also be conducted according to age at exposure, time since exposure (or attained age at risk), degree of dose protraction[3], and severity of the lenticular opacity.

Age distribution: The age distribution of the liquidators at the time of the Chernobyl accident is shown for a sample of highly exposed workers in text Table 3. Because we suspect that the ages shown there are somewhat older than those for the Liquidator population as a whole, a slightly younger age distribution was used in the calculations. For the age categories in text Table 3, the percents we assumed were: age 18-22 5%, 23-30 15%, 31-40 35%, 40-55 43%, over 55 2%.

[3] Some of the workers received most of their dose in a single acute (<60 seconds) while others received theirs over weeks or months.

Frequency of Spontaneous Cataracts: Since ionizing radiation exposure is associated primarily with posterior subcapsular cataracts (PSCs), we sought information on the prevalence or incidence of PSCs in relation to age and sex. Only three studies could be found that provide reasonably detailed data on PSC prevalence, and none on PSC incidence. These were the Framingham study (Krueger et al., 1980; Leibowitz et al., 1980; Sperduto et al., 1984), the Maryland Watermen Study (Adamsons et al., 1991) and the Beaver Dam Study (Klein et al., 1993). The differences in PSC prevalence according to sex were small and somewhat inconsistent across studies, so we used the combined-sex data in order to have more stable estimates. A summary of the age-specific prevalence proportions from these studies is shown in Table 7 (below). The criteria for PSCs were apparently different in the Watermen study (Adamsons et al., 1991) from those in the other two studies, since the proportions were lower in the Watermen study. Since the number of persons evaluated in the Watermen study was small, we relied mainly on the rates from the other two studies. The PSC prevalence proportions used for age-at-examination were: age ≤23 0.5%, 23-30 1%, 31-40 1.6%, 40-55 3.5%, 55-64 8%, 65-74 17%.

No data were found on PSC incidence.[4] However, methods exist to estimate age-specific incidence when one has the prevalence of a disease at various ages. An approximate method is given in reference (Podgor et al., 1983), namely,

$$I_j = (P_{j+1} - P_j) / ((1 - P_j) \cdot Y)$$

where I_j is the yearly incidence rate in the j^{th} age interval, P_j and P_{j+1} are the prevalence proportions in the j^{th} and $j+1^{th}$ age intervals, and Y is the number of years in the j^{th} interval.

Further technical details and assumptions are given in Podgor et al. (1983). Using this formula we estimated yearly incidence rates of PSC occurrence for the various ages: ages 31-40 0.06%, 40-55 0.17%, 55-64 0.68%, 65-74 1.0%. An arbitrary incidence rate of 0.05% for ages ≤30 was used, because no data were available for making an estimate.

Table 7: Prevalence of Posterior Subcapsular Cataracts (PSCs) by Age

Age	PSCs/No. Subjects	%	Study
30-38	2/204	1.0	Watermen
40-49	0/145	0	Watermen
43-54	~24/1520	1.6	Beaver Dam
50-59	3/166	1.8	Watermen
52-64	50/1214	4.1	Framingham
60-69	6/177	3.4	Watermen
65-74	75/715	10.5	Framingham
70-79	3/105	2.9	Watermen
75-85	61/310	19.7	Framingham
75-84	~115/807	14.3	Beaver Dam
80 +	0/36	0	Watermen

4 Prevalence represents the proportions of persons with a disease at a given time, as might be found by a screening examination. Incidence, on the other hand, is the rate of occurrence of new cases of the disease over time, as might be determined, for instance, by a series of repeated screenings. The incidence rate is virtually always lower than the prevalence.

To simplify calculations, we assumed that the persons in each age-at-exposure interval, as shown in Table 2, were at the midpoint age of the interval and that our initial screening will occur 8+ years after the exposure. We assumed the examination in year one was a prevalence screening, so that the age-specific prevalence rates applied to it, while all subsequent yearly examinations were incidence screenings so that age-specific incidence rates apply to these.

We assumed that attrition due to death, migration, termination of participation, etc. would be 30% by the end of a 15-year study. (Note, migration rates are quite low in the Ukraine, other than for the relocation that occurred due to Chernobyl, so this will be much less of a problem than it is in studies in the U.S.) We modeled the attrition by assuming that 70% would still be under follow-up at the end of 15 years, so we could calculate the average percent still under study for any arbitrary range of years. Under this assumption there would be an 89% follow-up rate after 5 years and a 55% follow-up after 25 years. These estimates are supported by the data in Table 8 (below) from long-term studies of cardiovascular disease in 40 - 59 year old male Kievites (Kwasha, 1987; Smirnova et al., 1990; Kwasha et al., 1994).

Table 8: Attrition Percentages From a Long-term Study of Cardiovascular Disease in Male Kievites

Duration	Percentage		
(Years)	Mortality	Non-participating Survivors	Participating Survivors
5	7.1	6.6	86.3
10	16.3	10.5	73.2
15	21.3	12.7	66.0

Although not radiation related the data suggests that we can anticipate even higher participation for a number of reasons. Many of the individuals were skewed to the young to middle age group so that mortality is not likely to be as large a factor. Also many liquidators, receive pensions for their Chernobyl service and must be available for periodic examination. Finally, personal concern about potential medical problems arising from their exposure provides additional motivation.

For the radiation-induced PSC cataracts, it is not clear whether a relative risk model or an absolute risk model is more appropriate. We used an excess absolute risk model since absolute risk coefficients were derivable from the preliminary Chernobyl Liquidator data whereas relative risks were not. We assumed a constant excess rate per year. In effect, we assumed that the initial screening examination, occurring 8-9 years after the radiation exposure, would detect the cataracts that had developed during the first 7-8 years, while subsequent screenings would each detect an extra two year's worth of radiation-induced cataracts, out to 12 - 13years for our initial 5-year study, to 22-23 years for a 15-year study, or to 32-33 years for a 25-year study. Modeling was performed using several different absolute risk coefficients - 0.0002, 0.0005, 0.001 per 10 years - in order to cover the range of plausible risks. The rationale for the coefficients is given in the text of the proposal.

III. OPHTHALMIC FOLLOW-UP: DESIGN AND PROTOCOL

Management and Oversight Personnel (Pages for biographical data in parentheses)

Basil V. Worgul, Ph.D. - P.I.	(Pages 34-35)
Nikolai Sergienko, M.D. - Co P.I.	(Pages 51-52)
Cecily Medvedovsky, M.D., Ph.D.	(Pages 45-46)
George Parkhomenko, M.D.	(Page 47)
Andre Ruban, M.D.	(Page 48)
Bin Wu, M.D.	(Page 54)

As described in the Organizational Structure (page 8) all seven centers are equipped for eye examinations including slitlamp biomicroscopy. Acad. Sergienko, Dr. Parkhomenko and Dr. Ruban - all of whom have been trained to evaluate radiation cataracts, both subjectively and by means of quantitative Scheimpflug and retro-illumination imaging, - will screen potential examiners. Two ophthalmologists from each site will be selected. The Drs. Worgul, Medvedovsky, Parkhomenko and Ruban will offer a 10 day training program to the 14 ophthalmologists. The program is designed to: provide the practitioners with information on the nuances of the radiation cataractogenesis, to familiarize them with the early biomicroscope picture of the pathology and to instruct them on properly filling out the Eye and Lens Examination forms. The program will include lectures, required reading, hands-on practicals and practice sessions. Only when there is consistent concordance between the instructors and the trainee on: detecting (and properly describing) early lens changes, the correct assignation of stage 1+ cataracts and accurate opacity localization will that ophthalmologist be enlisted into the program. Following the course, the instructors will then travel to each of the centers to assess the proficiency of the trainees in their actual work environments and to recommend changes in the facilities which may be necessary to improve efficiency. Once underway, the US contingent will schedule 3 site-visits per year and the members of the CEM will conduct occasional, unannounced, visits to assure maximum oversight.

Standardized forms (see Appendices II and III: pages 62-73) will be used by all the study examiners. The forms will be provided as multisheet carbons- with a Ukrainian top page matched in register with an English bottom sheet. The forms will be slightly modified from the current version to permit optical scanning of the inputted data. Both the upper and the lower sheets will be scan forms. On a biweekly basis, the centers will forward the completed forms to the CEM where Drs. Parkhomenko and Ruban who will review the submissions for completeness. If the data is found to be properly entered, the English second sheets, will be sent to the ERERL for data entry. If the forms are incomplete or incorrect, the examiners will be contacted for remedial action and if necessary will be reevaluated.

Prof. Likhtaryov and Dr. Chumak will select potential candidates for the cohort study. The cohort will be derived primarily from the USCRM registry for whom there exists primary dose records. The initial list will reflect the dose distribution required (see Table 4, page 20) and will include: 1) the 3000 individuals already processed retrospectively, 2) those whose dose records, while unconfirmed, are given high credibility based on the criteria detailed on page 17, 3) individuals whose cataract status is unknown, or suspected, by members of the research team. For those without retrospective confirmation, the presumed doses will be used **only to generate the initial list**. The USCRM will prioritize the retrospective assessment for that portion of the cohort.

Once prospective candidates on selected on the basis of dose they will then be group matched on age and screened for complicating pathologies as detailed in *Quality Control and Study Management* (page 24). Drs. Chumak and Vitte will contact the patients and organize scheduling for the eye examinations. Only the necessary contact data and personal medical profiles, if available, will be transmitted to examiners. The examiners will not receive information on doses or the circumstances of the individuals' Chernobyl activity.

LENS ASSESSMENT

After a standard ophthalmological work-up (see Eye Forms, Appendix III, pages 68-72) a mydriatic will be used to obtain maximum pupil dilatation (>5 mm) for lens examination. The study depends on the reliable identification of early lens changes in the posterior subcapsular (PSC) region of the lens. The emphasis is on detection rather than quantification of cataract. This strategy recognizes that given the relatively low dose range to be studied the cataracts which develop are not likely to become severe and in many cases may not be progressive (see Merriam and Focht, 1957). The goals are to establish absolute risk estimates for cataract induction in humans and to address the possibility that radiogenic cataracts are not deterministic. As such much depends on the criteria we choose to define the endpoint, cataract.

Early lens changes: Typically one of the earliest clinical expressions of radiation exposure of the lens is the appearance of a "polychromatic sheen" or "beaten brass" look to the posterior capsule (see Worgul and Merriam, 1983). This proved to be a problem in the study by Day and his associates (Eller et al, 1993; Day et al., submitted) of children residing in areas contaminated by the Chernobyl accident because the Lens Opacity Classification System (LOCS) III they were using does not have provision for the sheen. In our study we will score it as one of three possible early, or precataractous, lens changes. The others are the equally common although sometimes transient dots or vacuoles in the PSC or posterior superficial cortex. In our experience with radiation cataract development, generally when more than 10 dots or 5 vacuoles are present they are not likely to be transient so we have provided for distinguishing between such aberrations in the lenses.

Therefore the Lens Forms (Appendix II, pages 63-67) provide for three possibilities in scoring **early lens changes:**

1. A polychromatic sheen associated with the posterior capsule.
2. Individual (non aggregated) dots which number fewer than 10.
3. Individual vacuoles numbering fewer than 5.

Although the radiogenic changes will occur in the PSC region there is always the possibility of dots or vacuoles occurring elsewhere in an otherwise unremarkable lens. Therefore for completeness the scorer is asked to localize the observed changes as: anterior, posterior, equatorial and supranuclear. The scan forms to be used by the practitioner have provision for binary responses to each.

Cataract Scoring: While not pathognomonic, radiation cataracts develop in a characteristic, sequential fashion. The sequela is so predictable that it has served as the basis of the Merriam/Focht (1962) semi-quantitative scoring technique. Because it was specifically designed for gauging radiation cataract and its inherently unambiguous nature, a myriad of modified versions of the method have employed by a number of laboratories.

> **Stage 1+:** Discrete opacity which can take the form of a small spot readily discernible with retroilluminated light; aggregates of dots (>10) or vacuoles (>5), cortical spokes, waterclefts, or granulated opacities. The scorer must record the location as described above.
>
> **Stage 2+.** More extensive cortical changes collectively occupying approximately 25% of the noted area of the lens. If markedly less or more than 25% is involved a - Stage 1.5+ or 2.5+, respectively, is scored. For the "x.5" stages the scan forms provide "comment" space but are not sensitive to that staging for binary recording.

Stage 3+. Advanced changes. Light does not reach vitreous.

Stage 4+. Premature cataract. Near-total lens opacification. In some areas it is possible to see the nucleus or posterior cortex of the lens.

Stage 5+. Mature cataract. Total lens opacification.

The scoring method we are using to stage the cataracts incorporates the localizations as described for the early lens changes. Previous data by Merriam and Focht (1957) lead us to conclude that, because of the low-dose nature of the study and the relative youth of the population we will be monitoring, radiogenic cataracts beyond the 1-2+ stage will not be encountered. Nonetheless, the later stages are presented for completeness. The study is designed so that cataract onset is defined by the **1+ stage** which will be the **common endpoint used to determine risk**. Although that juncture will be the critical cataract data point as regards risk analyses, the patient will remain in the cohort and continue to be followed for the remainder of the study. Once that definitive stage is reached every effort will be made to have the liquidator brought to the IOH's Liquidator Ophthalmologic Facility in Kiev for Photo-documentation of the cataract. The aim is to obtain standard color slides and retroillumination photographs for the purpose of assessing other scoring modalities such as the LOCS III and Wilmer methods as well as immortalizing the clinical picture.

The photo-documentation will use a standard set of parameters to obtain images as consistent as possible. These conventions are used currently by the ERERL in its clinical studies. In the case of the Oxford system, eight pictures each eye (OD and OS) will be taken with the mid focal plane positioned anteriorly and then posteriorly. Four color slides of each eye will be taken using the photo-slitlamp setup as described below.

OXFORD RETROILLUMINATION CAMERA	
Film Type	Tri-X-400
Lens Aperture	5.6
Photography	4 images - OD Anterior
(all extraneous lights off)	4 images - OD Posterior
(note filmback numbers)	4 images - OS Anterior
	4 images - OS Posterior

TOPCON SL6E - PHOTO SLITLAMP	
Film Type	Ektachrome 200 (ASA) Color
Flash Intensity	5
Magnification	16x
Slit Height	Slightly larger than pupil diameter
Slit Width	0.3 - 0.4 mm
Viewing Angle	45° Temporal to each eye
Camera Position	90°
Focus	On nucleus with the Purkinji image in the AC
Photography	4 images - OD
(all extraneous lights off)	4 images - OS

If from the Kiev area, the patient may be included in the quantitative cataract study which has already begun. That investigation currently focuses on following the development of opacification, once initiated, in high dose Liquidators and is meant to elucidate the "natural history" of cataracts arising from radiation. Although we do not expect the opacities in the cohort to extend beyond the 1-2+ stage, as our experimental studies have shown (Wu et al., 1994), the state-of-the-art instrumentation may, reveal progressive changes in transparency which are too subtle to be resolved by any of the standard subjective methods.

The experience with experimental radiation cataract is that if both eyes receive the same dose the latent period (time between exposure and onset) is similar for cataract appearance. In the case of the Liquidators we will assume that although the radiation sources produced highly anisotropic fields, the routine activity of the individual would allow for both eyes to receive approximately equal total doses. Only in those cases of extremely acute, high dose-rate exposures might this assumption not hold. In any case both eyes will be analyzed and only when the second reaches the required 1+ stage will the individual become a potential candidate for inclusion in the on-going quantitative assessment.

The various components of the study will proceed as defined in the **Project Timeline/Milestones** section on page 32. We anticipate initiating data acquisition in the latter part year one and completing the first round of examinations for half the cohort one year after that. By emphasizing those liquidators who have had some form of retrospective dosimetry in that group we should be able to begin analyzing the results against dose. At that point we should have sufficient experience to judge the study's likelihood of achieving its aims.

Project Timeline / Milestones

During the first year we will:
- Organize, and task, the various components of the study
- Identify, train and test the examiners
- Site-certify the examination centers
- Convert to scan format, print, and distribute the current examination forms
- Complete the questionnaire development
- Select potential candidates and initiate contacts
- Setup hardware/software for scan entry of eye examination data
- Initiate retrospective dosimetry on potential candidates who lack it
- Link the necessary databases for the eye cohort
- Begin cohort study
- Develop nested case-control study

Year 2:
- First examinations completed for half the cohort (6000 liquidators)
- Retrospective dosimetry continues
- Database tweaking
- Preliminary cohort data analyses
- Implement case-control study logistics
- Begin case-control study
- Program assessment

Year 3:
- First examinations completed for the entire cohort (12,000) liquidators
- Data analyzed for those with reliable dosimetry
- Preliminary cohort data analyses
- Retrospective dosimetry continues

Year 4:
- Second round of examinations completed for half the cohort
- Data analyzed for those with reliable dosimetry
- Preliminary case-control data analyses
- Retrospective dosimetry continues

Year 5:
- Second round of examinations completed for the entire cohort
- First round of retrospective dosimetry completed for the eye cohort
- Data analyses
- Program assessment

Years 6 - 25
- Continue biennial examinations of cohort
- Continue case control study
- Update analyses and provide progress reports

FUNDING RESPONSIBILITIES AND REQUIREMENTS.

Ukrainian Contribution. The Ministry of Health will support the Ukrainian side of the effort. This includes the establishment of the clinic for the ophthalmological follow-up of the population, the involvement of the six remote regional polyclinics integrated into the clinic in Kiev, the commitment of personnel to conduct the follow-up, and support for the institutes involved in the data acquisition and analysis in Ukraine. Because of a prohibitively skewed exchange rate, the acquisition of items which require foreign currency will fall mainly to the American side of the effort.

The United States Commitment. The United States contingent requires support for the staff of the Eye Radiation and Environmental Research Laboratory (ERERL) to oversee the program, to initiate a study on a United States control group, to analyze the data, and to establish a database for ready reference. Dr. Roy Shore, who will oversee the epidemiological effort, will also require support.

In order to undertake the major cohort study which we have outlined in this proposal a significant commitment on the part of the United States is required. The monies will be primarily for the salary support of Dr.'s Worgul, Medvedovsky, Shore, an investigator to conduct ophthalmological validation assays and one full time equivalent data specialist for data entry and database maintenance. The extensive and intensive nature of the study will require relatively frequent travel by some component of the American contingent for site visiting and progress assessment. Therefore, travel and communications will also represent a significant cost category. Because we will encourage photo documentation of cataracts from the population, photographic supplies, and developing costs are expected to be significant. We feel that, at a minimum, the Kiev Clinic (which will see about 50% of all the Liquidators) should be supplied with a modern Photo-slitlamp for cataract documentation and the possibility of independent analyses. For the purposes of reporting and record updating some secretarial assistance will also be required.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Worgul, Basil Vladimir	Professor

EDUCATION *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
University of Miami (Florida)	B.S.	1969	Biology
University of Vermont	Ph.D.	1974	Zoology (Cell Biology)
Columbia University (Dept. of Ophthal.) College of Physicians & Surgeons	Post.-Doc.	1975-78	Eye Research

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1974 - 1975 Staff Associate, Dept. Ophthalmology, Columbia University.
1975 - 1979 Res. Associate, Dept. Ophthal., Columbia University. Post-doctoral Fellow of the NEI.
1979 - 1984 Asst. Prof. of Radiation Biology in Ophthalmology, Assoc. Director of the Eye Radiation Research Laboratory.
1980 - 1983 Consultant: Cataract Panel, National Advisory Eye Council.
1983 - 1992 Director, Resident's Basic Science Course, Dept. Ophthalmology, Columbia University.
1983 - Present Advisor: Scientific Committee 75 - NCRP: "Guidance on Radiation in Space Activities".
1984 - 1990 Associate Professor of Radiation Biology, Departments of Ophthalmology and Radiology.
1984 - Present Director of the Eye Radiation and Environmental Research Laboratory, Columbia University.
1987 - 1988 Robert E. McCormick Scholar - Research To Prevent Blindness.
1989 - 1990 Member, Committee One - ICRP: Task Force on Radiation Risk To the Eye.
1989 - Present Member, Space Radiation Health Discipline Working Group, NASA.
1990 - Present Member, Scientific Committee 86-NCRP: "Hot Particles and the Eye".
1990 - Present Prof. of Radiation Biology, Depts. Ophthal. and Radiology, Columbia University.
1992 - Present Member of Federal Demonstration Project Subpanel II on Technical Reporting - NAS.
1992 - Present Foreign Member of the Academy of Sciences of Ukraine.

PUBLICATIONS - *A PARTIAL LISTING OF RELEVANT PAPERS (EXCLUDES ABSTRACTS)*

Worgul, B.V. and Rothstein, H. (1975). Radiation cataract and mitosis. Ophthal. Res. 7:21-32.

Worgul, B.V., Merriam, G.R., Jr., Szechter, A. and Srinivasan, B.D. (1976). The lens epithelium and radiation cataract. I. Preliminary studies. Arch. Ophthal. 94:996-999.

Worgul, B.V. and Rothstein, H. (1977). On the mechanism of radiocataractogenesis Medikon 6:5-14.

Worgul, B.V. and Rothstein, H. (1975). Radiation cataract and mitosis. Ophthal. Res. 7:21-32.

Worgul, B.V., Bito, L.Z. and Merriam, G.R. (1977). Intraocular inflammation produced by X-irradiation. Exp. Eye Res. 25:53-61.

Worgul, B.V. and Merriam, G.R., Jr. (1980). The lens epithelium and radiation cataract. II. Rad. Res. 84:115-121.

Worgul, B.V. and Merriam, G.R., Jr. (1981). The role of inflammation in radiation cataractogenesis. Exp. Eye Res. 33:167-173.

Broglio, T. and Worgul, B.V. (1982). The lens epithelium and radiation cataract. IV. Ultrastructural studies Virchows Arch. Cell Path. 39:49-57.

Rothstein, H, Worgul, B.V., Medvedovsky, C. and Merriam, G.R., Jr. (1982). G0/G1 arrest of cell proliferation in the ocular lens prevents radiation cataract development. Ophthal. Res. 14:215-220.

Worgul, B.V., Low, S. and Merriam, G.R., (1982). The lens epithelium and radiation cataract. III. The effect of age on radiation induced nuclear fragmentation in the meridional rows. Rad. Res. 91:181-185.

Merriam, G.R., Jr. and Worgul, B.V. (1983). Experimental Radiation Cataract - Its Clinical Relevance. Bull. NY Acad. Med. 59:372-392.

Merriam, G.R., Worgul, B.V., Medvedovsky, C., Zaider, M. and Rossi, H. (1984). Accelerated heavy particles and the lens. I. Cataractogenic potential. Rad. Res. 98:129-140.

Worgul, B.V., Merriam, G.R. and Medvedovsky, C. (1985). Accelerated heavy particles and the lens. II. Cytopathological changes. Invest Ophthal Vis Sci 27:108-114.

Rini, F., Worgul, B.V. and Merriam, G.R., Jr. (1986) Radiation cataractogenesis. J.N.Y. Acad. Med. 62:744-763.

Worgul, B.V. (1986). Cataract analysis and the assessment of radiation risk in space. Adv. Space Med. 6:285-293.

Geard, C. and Worgul, B.V. (1987). The lens and cataract: Clastogenic responses in epithelial cells of the organ cultured rat lens. Environ. Mutag. 9:111-122.

Krebs, W. Krebs, I., Merriam, G.R. and Worgul, B.V. (1988). The effect of accelerated argon ions on the retina.. Rad.Res. 115:92-201.

Worgul, B.V. (1988). Accelerated heavy particles and the lens. V. Cataract enhancement by dose fractionation. Ophth. Res. 20:143-148.

Odrich, S., Merriam, G.R., Medvedovsky, C. and Worgul, B.V. (1988). Micronucleation in the lens epithelium due to exogenous physical and chemical mutagens. Lens Res. 5:203-216

Worgul, B.V., Medvedovsky, C.M. and Merriam, G.R. (1989). Cortical cataract development - the expression of primary damage to the lens epithelium Lens & Eye Tox. Res. 6:559-571.

Worgul, B.V., Merriam, G.R., Medvedovsky, C. and Brenner, D. (1989). Accelerated heavy particles and the lens. III. Enhanced cataractogenesis by dose fractionation of 570 MeV/amu ^{40}Ar ions. Rad. Res. 118:93-100.

Krebs,W., Krebs, I., and Worgul, B.V.(1990) The effect of accelerated iron ions on the retina. Rad. Res. 123:213 - 219.

Brenner, D.J., Medvedovsky, C., Huang, Y., Merriam, G.R., Jr., and Worgul, B.V. (1991) Accelerated heavy particles and the lens VI: RBE studies at low dose. Rad. Res. 128:73-81.

Medvedovsky, C., and Worgul, B.V. (1991) Neutron effects on the lens. Rad. Res. 128:S103-S110.

Worgul, B.V., David, J., Odrich, S., Merriam, G.R., Jr., Medvedovsky, C., Merriam, J.C., Trokel, S.L. and Geard, C.R. (1991). Evidence of genotoxic damage in human cataractous lenses. Mutagenesis 6(6):495-499.

Worgul, B.V., Brenner, D.J., Medvedovsky, C., Merriam, G.R., Jr. and Huang, Y. (1993). Accelerated heavy particles and the lens VII: The cataractogenic potential of 450 MeV/amu iron ions. Invest. Ophthal. Vis. Sci.. 34(1):184-193.

Brenner, D.J., Medvedovsky, C., Huang, Y. and Worgul, B.V. (1993) Accelerated heavy particles and the lens VIII: Comparisons between the effects of iron ions (190 keV/μm and argon ions (88 keV/μm). Rad. Res. 133:198-203.

Tao, F., Medvedovsky, C., David, J., Broglio, T., Powers-Risius, P., Alpen, A. and Worgul, B.V. (1993) Accelerated heavy ions and the lens IX. Late effects of LET and dose on cellular parameters in the murine lens . Int. J. Rad. Biol. 64:103-111.

Medvedovsky, C., Worgul, B.V., Huang, Y., Brenner, D.J., Tao, F., Miller, J., Zeitlin, C. and Ainsworth, E.J. (1994) The influence of dose, dose-rate and particle fragmentation on cataract induction by energetic iron ions. Adv. Space Res. 14:475-482.

Wu, B., Medvedovsky, C. and Worgul, B.V. (1994) Non-subjective cataract analyses and its application in space radiation risk assessment. Adv. Space Res. 14:493-500.

Worgul, B.V. and Medvedovsky, C. (In Press) Radiation cataract: a potential late effect of the Chernobyl experience. In: Occupational Health Consequences of the Chernobyl Accident.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Anspaugh, Lynn Richard	Biophysicist

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Nebraska Wesleyan University	A.B.	1959	Physics
University of California, Berkeley	Mas.	1961	Physics
University of California, Berkeley	Ph.D.	1963	Physics

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1963-1974 Biophysicist, Lawrence Livermore Lab., Biomed. and Environ. Res. Div.
1974-1975 Biophysicist & Group Leader for Applied Environ. Sci., Lawrence Livermore Laboratory
1976-1982 Biophysicist & Section Leader for Analysis and Assessment, Lawrence Livermore Laboratory
1982-1992 Biophysicist and Division Leader, Environmental Sci. Div. Lawrence Livermore Laboratory
1979-Present Scientific Director, NTS Off-Site Radiation Exposure Review Project
1986-Present Scientific Director, Basic Environment Compliance and Monitoring Prog., Nevada Test Site
1992-Present Biophysicist and Director for Risk Sciences Center, Lawrence Livermore Laboratory
1992-Present Co-Director, Lawrence Livermore Lab., Risk Sciences Program

SELECTED PUBLICATIONS

Anspaugh, L.R., Catlin, R.J. and Goldman, M. (1988) The global impact of the Chernobyl reactor accident. Science 242:1513-1519.

Anspaugh, L.R., Bennett, B.G., Bouville, A., Fritelli, L., Hagen, A. and Pavlovsky, O. (1988) Exposures from the Chernobyl accident. In: *Sources, Effects and Risks of Ionizing Radiation*, United Nations Scientific Committee on the Effects of Atomic Radiation, report to the General Assembly (United Nations, New York, No. E.88.1X.7.

Mettler, F.A., Sinclair, W.K., Anspaugh, L., Edington, C., Harley, J.H., Ricks, R.C., Selby, P.B., Webster, E.W. and Wyckoff, H.O. (1990) The 1986 and 1988 UNSCEAR reports: findings and implications. Health Phys. 58:241-250.

Anspaugh, L.R., Ricker, Y.E., Black, S.C., Grossman, R.F., Wheeler, D.L., Church, B.W. and Quinn, V.E. (1990) Historical estimates of external γ-exposure and collective external γ-exposure from testing at the Nevada test site. II. Test series after Hardtrack II, 1958, and summary. Health Phys. 59:525-532.

Cederwall, R.T., Ricker, Y.E., Cederwall, P.L., Homan, D.N. and Anspaugh, L.R. (1990) Ground-based air-sampling measurements near the Nevada test site after atmospheric nuclear tests. Health Phys. 59:533-540.

Church, B.W., Wheeler, D.L., Campbell, C.M., Nutley, R.V. and Anspaugh, L.R. (1990) Overview of the Department of Energy's off-site radiation exposure review project (ORERP). Health Phys. 59:503-510.

Ng, Y.C., Anspaugh, L.R. and Cederwall, R.T. (1990) ORERP internal dose estimates for individuals. Health Phys. 59:693-713.

Anspaugh, L., Bouville, A., Grant, T., Haywood, S., Kirchner, T., Marter, W., Otis, M. and Ramsdell, J.V. (1989) Dose reconstruction. In: *Proceedings of the CEC/DOE Workshop on Uncertainty Analysis*. Santa Fe, N.M., November 13-16. C.E. Elderkin and G.N. Kelly, Eds. Pacific Northwest Laboratories, Richland, WA. PNL-SA-18372, pp. 25-27.

Goldman, M., Nelson, R.C., Bollinger, L., Hoover, M.D., Templeton, W. and Anspaugh, L. (1991) Potential health risks from postulated accidents involving the Pu-238 RTG on the Ulysses solar exploration mission. In: *Proceedings for the Eighth Symposium on Space Nuclear Power Systems, Part One*. M.S. El-Genk and M.D. Hoover, Eds., American Institute of Physics, New York, NY, pp. 152-164.

Kercher, J.R. and Anspaugh, L.R. (1991) Analysis of the Nevada-Applied-Ecology-Group model of transuranic radionuclide transport and dose. J. Environ. Radioact. 13:191-216.

Anspaugh, L.R. (1991) A reply to: Let's all play by the same rules. Health Phys. 61:143-150.

Shigematsu, I., Anspaugh, L.R., Baryakhtar, V.G., Bennett, B.G., Coppee, G.H., Copulon, R., Fry, F., Gheorghiev, G.K., Gubanov, V.A., Jovanovich, J., Kelly, N., Kuramoto, A., Lee, T.R., Mettler, F.A., Rosen, M., Salo, A., Smales, E., Steinhausler, F., Stepanenko, A.V., Voloshchuk, V.V. and Waight, P. (1991) *The International Chernobyl Project - Technical Report: Assessment of Radiological Consequences and Evaluation of Protective Measures*. International Advisory Committee, International Atomic Energy Agency, Vienna, Austria.

Daniels, J.I., Andricevic, R., Anspaugh, L.R. and Jacobson, R.L. (1992) *Risk-based Screening Analysis for Assessing the Contribution to Potential Public Health Risk from Ingestion of Ground Water Contaminated by Radionuclides Introduced at the Nevada Test Site (NTS)*. Lawrence Livermore National Laboratory, Livermore, CA, UCRL-ID-112789DR.

Daniels, J.I., Andricevic, R., Anspaugh, L.R. and Jacobson, R.L. (1993) Risk-based screening analysis of ground water contaminated by radionuclides introduced at the Nevada test site (NTS). In: *Pilot Study Risk Assessment for Selected Problems at the Nevada Test Site (NTS)*. J.I. Daniels, Ed., Lawrence Livermore National Laboratory, Livermore, CA, UCRL-LR-113891, pp. 69-97.

Layton, D.W., Aspaugh, L.R., Bogen, K.T. and Straume, T. (1993) Risk assessment of soil-based exposures to plutonium at experimental sites located on the Nevada test site and adjoining areas. In: *Pilot Study Risk Assessment for Selected Problems at the Nevada Test Site (NTS)*. J.I. Daniels, Ed., Lawrence Livermore National Laboratory, Livermore, CA, UCRL-LR-113891, pp. 19-67.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Andre Bouville	Senior Radiation Physicist Radiation Effects Branch, NCI, NIH

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
University Paul-Sabatier, Toulouse, France	B.S. (eq.)	1960	Physics
University Paul-Sabatier, Toulouse, France	M.S. (eq.)	1963	Nuclear Physics
University Paul-Sabatier, Toulouse, France	Ph.D. (eq.)	1970	Physics

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

Previous employment

1962 - 1965 Graduate Assistant, Department of Atomic Physics, University Paul-Sabatier, Toulouse, France.

1965 - 1966 Exchange Student, National Atomospheric and Oceanic Administration, Silver Spring, MD.

1967 - 1970 Graduate Assistant, Department of Atomic Physics, University Paul-Sabatier, Toulouse, France.

1970 - 1972 Scientific Secretary, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), New York, NY, and consultant to that organization from 1973 to date.

1972 - 1984 Assistant to the Director of Protection at the French Atomic Energy Commission, Fontenay-aux-Roses, France (following promotions from physicist to Group Chief and to Deputy Director of a Division).

1984 - 1992 Expert, Radiation Effects Branch of the National Cancer Institute (NCI), Bethesda, MD.

1992 - Date Senior Radiation Physicist, Radiation Effects Branch of the National Cancer Institute (NCI), Bethesda, MD.

Experience and honors.

Consultant, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

Member, Committee 2 of the International Commission on Radiological Protection (ICRP).

Team Leader, International Chernobyl project of the International Atomic Energy Agency (IAEA).

Member, Working groups 7.1 and 7.2 of the US-USSR Joint Coordinating Committee on Civilian Nuclear Reactor Safety.

Member, Committee on an Assessment of CDC Radiation Studies of the National Research Council (NRC).

Member, National Council on Radiation Protection and Measurements (NCRP); chairman, Scientific Committee 57-16 and member of Scientific Committees 1-5, 64-16 and 84-1.

Member, NCI Site Review Committee for University of Utah Contract for Epidemiology Studies.

Member, Dose Evaluation and Risk Assessment Advisory Panel (State of Idaho, Department of Health and Welfare).

Chevalier, Ordre des Palmes Academiques, France.

Recent publications

Bouville, A., Dreicer, M., Beck, H.L., and Wachholz, B.W. (1988). Assessment of Iodine-131 transfer to cow's milk and to man resulting from the Nevada weapons tests of the 1950's. Seventh International Congress of the IRPA. Radiation Protection Practice, pp. 1387-1390. Pergamon Press.

Bouville, A. and Lowder, W.M.(1988). Human population exposure to cosmic radiation. Radiation Protection Dosimetry 24(1/4): 293-299.

Bennett, B.G. and Bouville, A. (1988). Radiation doses in counties of the Northern Hemisphere from the Chernobyl nuclear reactor accident. Environment International. 14:75-82.

Bouville, A. (1989). L'approche de la gestion du risque radon dans les habitations aux Etats-Unis. Radioprection 24:329-339.

Bouville, A., Dreicer, M., Bech, H.L., Hoecher, H.W. and Wachholz, B.W. (1990). Models of radioiodine transport to populations within the continental U.S. Health Physics 59:659-668.

Dreicer, M., Bouville, A. and Wachholz, B.W. (1990). Pasture practices, milk distribution, and consumption in the continental U.S. in the 1950s. Health Physics. 59:627-636.

Beck, H., Helfer I.K., Bouville, A. and Dreicer, M. (1990). Estimates of fallout in the continental U.S. from Nevada weapons testing based on gummed-film monitoring data. Health Physics. 59:565-567.

Bouville, A., Dreicer, M and Wachholz, B.W. Assessment of exposure to ^{131}I in the continental United States resulting from the Nevada atmospheric nuclear tests. Proceedings of the CEC Seminar on Methods and Codes for Assessing the Consequences of Nuclear Accidents. Arhens, May 7-11, 1990. Commission of the European Communities report EUR 13013, pages 239-262.

Bouville, A., Dreicer, M. and Wachholz. Assessment of world-wide contamination and doses from the Chernobyl accident. Proceedings of the International Conference on Nuclear Accidents and the Future of Energy. Lessons learned from Chernobyl. Paris. April 15-17, 1991. SFEN/SNC report, pages 1/9-206.

Anspaugh, L., Bouville, A., Bennett, B.G. and Wachholz, B.W. Radiation Exposure of the Population. The International Project. Proceedings of an International Conference. Assessment of Radiological Consequences and Evaluation of Protective Measures. IAEA, Vienna, Austria, pages 27-31. 1991.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Chumak, Vadim V.	Senior Scientist

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Kiev State University	M.D.	1986	Radiophysics
Kiev State University	Ph.D.	1992	Radiobiology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1986-Present Ukrainian Scientific Center for Radiation Medicine, Department of Dosimetry and Radiation Hygiene, Ukraine.

PUBLICATIONS: (Includes only full papers)

Khrushch, V.T., Repin, V.S. Chumak, V.V., et al. Characteristics of radionuclide intake by inhalation. Medical Aspects of the Chernobyl Accident, IAEA Tec. Doc. 516:217-228, 1989.

Chumak, V.V. and Korobeynikov. Spatial and time pattern of dose fields and external doses of evacuated population. Problems of Radiation Medicine, Kiev, 1991.

Repin, V.S., Chumak, V.V., et al. Radiation aspects of the Chernobyl accident. Theses Obninsk, 1990.

Chumak, V.V., Likhtaryov, I.A., et. al. Formalized questionnaires for reconstruction of external and internal exposure doses and relevant software. Actual problems of internal exposure dosimetry. Theses, Gomel, 1989.

Chumak, V.V. Analysis of the effectiveness of usage of various population dose reduction methods in the near zone of Chernobyl. Assessment of Medical Consequences of the Chernobyl Accident. Theses, Kiev, 1991.

Likhtaryov, I.A., Chumack, V.V. and Repin, V.S. Retrospective reconstruction of individual and collective external gamma doses of population evacuated after the Chernobyl accident. Health Phys. (In Press).

Likhtaryov, I.A., Chumack, V.V. and Repin, V.S. About the effectiveness of emergency countermeasures in the 30 km zone at the early phase of the Chernobyl accident. Health Phys. (In Press).

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Kundiev, Yuri Ilych	Professor

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Medical Institute, Kiev, Ukraine	M.D.	1951	Medicine
Inst. of Labour, Hyg. & Occup. Dis., Kiev, Ukraine	Ph.D.	1954	Physiology
Inst. of Labour, Hyg. & Occup. Dis., Kiev, Ukraine	Ph.D.	1967	Toxicology
Inst. of Labour, Hyg. & Occup. Dis., Kiev, Ukraine	Ph.D.	1969	Occup. Dis.

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1954-1955 Junior Sci. Worker, Laboratory of Labour Physiology, Institute of Labour Hygiene and Occupational Diseases, Kiev, Ukraine

1955-1963 Head, Laboratory of Individual Protective Equipment, Institute of Labour Hygiene and Occupational Diseases, Kiev, Ukraine

1963-1964 Deputy Director, Institute of Labour Hygiene and Occupational Diseases, Kiev, Ukraine

1964-Present Director, Institute of Labour Hygiene and Occupational Diseases, Kiev, Ukraine

1965-Present Chairman, Problem Commission "Scientific Basis of Labour Hygiene and Occupational Pathology", Ukraine.

1972-Present Member, WHO Expert Committee on Occupational Health.

1973-Present Director, WHO Expert Committee on Occupational Health.

1974-Present Member, Academy of Medical Sciences of the USSR.

1979-Present Academician, Academy of Sciences of the Ukraine

1981-Present Honorary Member, Society of Occupational Health, Poland.

1987-Present Member, International Scientific Group, "Methods to Assess and Reduce Injury from Chemical Accidents".

1990-Present Academician-Secretary of the Department of Medical Problems, Academy of Sciences of the Ukraine.

SELECTED PUBLICATIONS

Kundiev, Y.I. (1978) Identification, measurement and evaluation of airborn contaminants in the working environment. Intern. Symp."Control of Airborn Pollution in the working environment". Stockholm, 203-208

Kundiev, Y.I. (1980) Results and prospects for scientific research on labour hygiene in agriculture in the USSR. Agr. Med. Rural Health, I:5-9.

Kundiev, Y.I. (1983) *Occupational Diseases of Rural Workers*, a manual (Eds. Y.I. Kundiev, E.P. Krasnyuk), pp. 262-269.

Bochkov, N.P. and Kundiev Y.I. (1985) Chemicals: a possible cause of genetic disorders. Methods for estimating risk of chemical injury: Human and non-human biota and ecosystems (Eds. V.B. Vouk et.al.), pp. 343-346.

Izmerov, N.F. and Kundiev Y.I. (1986) Nature and health effects of occupational factors. *In: Epidemiology of Occupational Health*, pp. 17-42.

Kundiev, Y.I., Krasnyuk, E.P. and Viter, V. (1986) Specific features of the changes in the health status of female workers exposed to pesticides in greenhouses. Toxicol. Lett., 33:85-89.

Kundiev, Y.I. and Navakatikyan, A.O. (1986) Study of combined effects. Epidemiology on Occupational Health, pp. 20-22.

Becking, A.C., Piotrowsky, G. and Kundiev, Y.I. (1989) Health assessment and medical response. Methods for assessing and reducing injury from chemical accidents. Scope 40. IPCS Joint Symp. SGOMSEC 6:46-65.

Kundiev, Y.I. (1989) Actual hygienic problems of agricultural work in the USSR. The First Finnish-Soviet Symposium on Occupational Health and Safety in Agriculture, 21-25 August, 1989; Helsinki, 1991, pp. 8-13.

Kundiev, Y.I., Chusova, V.N. and Karakashyan, A.N. (1990) Health effects of pesticides on female beet-growers. La Med. del Lavoro, 6:513-516.

Kundiev, Y.I. and Chernyuk, V.I. (1991) Physiological basis of agricultural machinery optimization, the USSR experience. Psychosocial factors affecting work in agriculture and forestry. Proc., XI Joint Int. Erg. Symp., As, Norway, pp. 16-24.

Kundiev, Y.I. and Grumin, G.T. (1991) Chronotoxicological classification of chemical substance due to their absorption through the skin. Vestnik Akademii Meditsinskikh, Nauk, pp. 51-54.

Kundiev, Y.I., Krasnyuk, E.P. and Ershova, M.A. (1991) Occupational morbidity in the Ukraine. Vrachebnoye delo, 10:116-119.

Kundiev, Y.I. and Trakhtenberg, I.M. (1991) Ecologo-hygienic aspects of the problem of heavy metals as technogenic pollutants. Gigiyena truda 27:3-8.

Kundiev, Y.I. and Dobrovolsky, L.A. (1992) Indoor air quality standards and perspectives of their development in Ukraine. Quality standards for the indoor environmental scientific and regulatory aspects. Abstracts, Praha, 27.

Kundiev, Y.I. (1992) Hazards to male reproduction function in agriculture. A review. Third Intern. Symp.: Issues in Health, Safety and Agriculture, 10-15 May, 1992, Saskatoon, Canada, 152.

Kundiev, Y.I. and Dobrovolsky, L.A. (1992) Policy, sanitary legislation on indoor air quality in Ukraine. Indoor climate of buildings. Bratislava, 29-33.

Kundiev, Y.I. (1992) Priority directions of fundamental medico-biological achievements. Vrachebnoye delo., No. 11-12, pp. 3-7.

Kundiev, Y.I. and Krasnyuk, E.P. (1992) Degenerative-dystrophic spine diseases in agricultural workers. Abstracts, Int. Symp. Work Related Dis. Prevention and Health Promotion, 27-30 October, 1992, Linz, Vienna, 30.

Kundiev, Y.I. (1992) Occupational hygiene of pesticides use in agriculture. General principles of pesticide poisoning prevention. Health aspects of pesticide use. Collect. of Train. Materials, Moscow, 114-123.

Kundiev, Y.I. and Kagan, Y.S. (1992) Anticholinesterases used in the USSR: poisoning, treatment, and preventive measures. Clinical and Exper. Toxicology of Organophosphates and Carbamates. Oxford e.a.: Butterworth-Heinemann, Tld., 494-501.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Likhtaryov, Ilia Aronovich	Professor

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
All-Union Moscow Polytechnical Institute	diploma engineer physicist	1962	Physics

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1960-1964	Engineer Physicist, Radiological Department of the Kiev Regional Sanitary Epidemiological Station.
1964-1967	Post-graduation education (Radiation Biophysic) in the Leningrad Institute of Radiation Hygiene.
1967-1986	Head of Dosimetric Biophysic Laboratory in the Leningrad Institute of Radiation Hygiene.
1983-1991	Member of the National Commission of Radiological Protection.
1986-Present	Head of Dosimetric and Radiation Hygiene Department of the Ukrainian (former All-Union) Scientific Centre of Radiation Medicine.
1988-Present	Member of ICRP (Committee 2).
1988-Present	Candidate of Technical Science (Ph.D.) l- Radiation Biophysics.
1988-Present	Doctor of Physical Mathematical Science (doctor of Science) - Biophysics
1988-Present	Professor of Radiation Biophysics
1988-Present	State Prize Laureate

SELECTED PUBLICATIONS

Osanov, D.P. and Likhtaryov, I.A. (1974) Radiation dosimetry of incorporated radionuclides (monografy). Moscow, "Atomizdat" (in Russian).

Likhtaryov, I.A. and Shamov, V.P. (1973) Experimental and mathematical procedures for the calculation of metabolic contents in compartment models of the radioisotope metabolism of the Ba, Cs, Ca, Sr, I. In: *Health Physics Problems of Internal Contamination.* Publ. Hungarian Academy of Sciences, Budapest, pp. 161-166.

Likhtaryov, I.A., Dobroskok, A.P., et al. (1975) A study of certain characteristics of strontium metabolism in a homogenous group of human subjects. Health Phys. 28:49-60.

Likhtaryov, I.A. and Krasnostctekova, G.P. (1972) Mathematical model of endocrine regulation of calcium-strontium metabolism and its experimental study. Second International Conference on Strontium Metabolism. Glasgow and Strontium, August 16-19, pp. 229-237.

Likhtaryov, I.A., Shandala, N.K., Gulko, G.M., Kairo, I.A., Repin, V.S. and Romanenko, A.E. (1989) Radioactive iodine concentrations in elements of environment and exposure doses to the thyroid among inhabitants of Kiev after the Chernobyl accident. International Symposium on Environmental Contamination Following a Major Nuclear Accident, Vienna, Austria, October. IAEA-SM-306, Vienna, pp. 247-248.

Likhtaryov, I.A. and Kovgan, L.N. (1990) Doses of irradiation to the Ukrainian population as a result of the Chernobyl accident. Report to the Seminal on Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, Chernobyl. Luxembourg, 1-5 October.

Los', I.P., Likhtaryov, I.A., Shandala, N.K., Gulko, G.M., Repin, V.S., Bobyleva, O.A., Komarikov, I.Y., Vasilev, A.Y., Kovgan, L.N., Stepanenko, V.N. and Andreeva, V.V. (1989) Radiation protection and health physics evaluation of movements of radioactive cesium and strontium from soils to plants and milk in the Ukraine. International Symposium on Environmental Contamination Following a Major Nuclear Accident, Vienna, Austria, 16-20 October. IAEA SM-36, Vienna, pp. 243-245.

Likhtaryov, I.A. and Kovgan, L.N. (1991) How much does conservativeness of the Chernobyl dose estimates cost? International Seminar on Intervention Levels and Countermeasures for Nuclear Accidents. Cadarache, France.

Likhtaryov, I.A., Kovgan, L.N., Anisenko, E.A., Belaya, L.N., Boiko, Z.N. and Vavilov, S.E. (1991) System of arrangement for radiological and dosimetric data and object law formation of dose for Ukrainian population. Problems of Radiological Medicine, Kiev (in Russian).

Likhtaryov, I.A., Shandala, N.K., Gulko, G.M., Kairo, I.A. and Chepurnoy, N.I. (1991) Hygienic estimation of thyroid doses of Ukrainian population after the Chernobyl accident. "Vestnic AMS of the USR", N2, pp. 44-47 (in Russian).

Likhtaryov, I.A., Shandala, N.K., Gulko, G.M. and Kairo, I.A. (1991) On "control-level" conception and possibility of its realization for emergency radiation-hygienic standardization. Hyhienic and Sanitation, N3, pp. 86-88 (in Russian).

Likhtaryov, I.A. (1991) Radioecological and dosimetric models used for retrospective and predictive assessment of human exposure after the Chernobyl accident. Rad. Res., Congress Proceedings, 9th ICRR, Toronto, 7-12 July.

Likhtaryov, I.A., Gulko, G.M. and Kairo, I.A. (1991) Countermeasures and their efficiency in the radioiodine danger conditions for Kiev residents in May, 1986. International Seminar on Intervention Levels and Countermeasures for Nuclear Accidents, 7-11 October, Cadarache, France. Book of Abstracts, International Union of Radioecologists. Cadarache, 1991.

Likhtaryov, I.A., Shandala, N.K., Gulko, G.M., Kairo, I.A. and Chepurnoy, N.I. (1993) Exposure doses to thyroid of the Ukrainian population after the Chernobyl accident. June, Health Physics.

Likhtaryov, I.A., Gulko, G.M., Kairo, I.A., Los, I.P, Shandala, N.K., Henrichs, K. and Paretzke, H.G. (1993) Estimation of thyroid doses and effectiveness of antiiodine measures in Kiev after the Chernobyl accident. Accepted for publication in Health Physics.

Jacob, P., Medkbach, R., Paretzke, H.G., Likhtaryov, I., Los, I., Kovgan, L. and Komarikov, I. (1992) Dose rates in air after desium depositions on grassland. Submitted to Health Physics.

Likhtaryov, I., Kovgan, L., Novak, D., Vavilov, S., Jacob, P. and Paretzke, H.G. (In Press) Effective dose due to the Chernobyl external irradiation for different population groups of Ukraine. Health Physics.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Medvedovsky, Cecily	Research Scientist

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Tashkent Medical Institute	M.D.	1942	Ophthalmology
Institute of Industrial Hygiene & Occupational Diseases, Kiev, USSR	K.M.S. (Ph.D.)	1976	Ophthalmic Radiation Biology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1942-1945 Surgeon, Evacuation Hospitals 3668 and 1977, Aktash Rostovon-Don.
1947-1949 Clinical Postgraduate Course in Ophthalmology. Certificate: Advanced Qualification in Ophthalmology. Kiev
1947-1978 Member of Kiev Ophthalmology Research Society, Kiev.
1951-1959 Ophthalmologist, Children's Hosp., Dnieper Dept. Public Health.
1959-1979 Sr. Staff Scientist, Research Institute for Occupational Disease, Kiev; Radiation
1980-1983 Sr. Staff Associate, Eye Radiation Research Laboratory, Dept. of Ophthalmology, Columbia University
1983-present Research Scientist: E.R.E.R.L.; Dept. of Ophthalmology, Columbia University.

PUBLICATION LIST: *THIS LIST COMPRISES A CROSS-SECTION OF SELECTED PAPERS AND EXCLUDES ABSTRACTS*

Medvedovsky, C., Likhtarev, Y. (1965). Accumulation and elimination of incorporated 32P in the eye tissue. Radiobiologiya. 5:213-217.

Medvedovsky, C. (1966). Method of determination of absorbed doses of beta radiation in eye tissues. In Problems of Experimental and Clinical Radiology. Kharkov, 2:219-223.

Medvedovsky, C. (1967). A comparative estimate of ocular effect of incorporated beta radiators 32P, 35S and 45Ca. Labour Hygiene. pp. 191-195.

Medvedovsky, C. (1970). Vascular reactions from radiation. In Problems of Ophthalmology. Odessa. pp. 246-247.

Medvedovsky, C. (1970). Experimental data on the combined effect of the beta radiators and radiant heat on the organ of vision. In Problems of Experimental and Clinical Radiology, Kiev, 6:99-100.

Pines, A.G., Medvedovsky, C., Shepelev, V.N. (1970). Experience with the mathematical analysis of a conjoint action of infrared and ionizing radiation on the regional blood pressure. In Hygienic Assessment of Radiation and Nonradiation - Age Factors and their Combinations. Leningrad, pp. 44-46.

Khvoinitskaya, M.A., Dobrovol'skii, L.A., Medvedovsky, C. and Pugachevskii, V.P. (1970). Concerning the experimental grounds of the maximum permissible P32 content in the human organism and the air of working premises. In Radiobiological Experiment and a Human, Atomizdat, pp. 167-173, Moscow.

Medvedovsky, C. (1970). Some evidence on the eye state in workers engaged in the high quality glass production Gigiena i Sanitariya, 3:105-106.

Medvedovsky, C., Pines, A.G. and Shepelev, V.N. (1971). An effect of small ionization doses on humans working in metallurgy. In Labour Hygiene, Kiev, 7:135-140.

Rappoport, M.B., Katsnelson, G.M., Postnikov, L.N. and Medvedovsky, C. (1973). A comparative estimation of neutron and X-ray radiation biological effect. In Exp. and Clin. Radiology, Kiev, 9:11-18.

Medvedovsky, C. (1974). Some data on the eye state in humans working with ionizing radiation. In Protection from Professional Radiations, Kiev, pp. 12-14.

Medvedovsky, C. (1975). Experimental grounds for the RBE of neutrons from the "cataractogenesis" test. In Radiational Hygiene, Leningrad, 5:194-197.

Medvedovsky, C. (1977). Cataractogenic effect and RBE of 2 MEV neutrons. Meditsinskaya radiologiya, 10:84-88.

Monastyrskaya, B.I., Simonenkova, V.A. and Medvedovsky, C. (1978). Early effects of neutron action on epithelial cells in animals, Leningrad, Academy of Sciences, USSR, Nauka, pp. 128.

Worgul, B.V., Merriam, G.R., Jr., and Medvedovsky, C. (1981). Radiation cataractogenesis in the irradiated rabbit eye. Current Eye Res. 1:275-80.

Worgul, B.V., Rothstein, H., Medvedovsky, C. and Merriam, G.R. (1982). Radiation cataractogenesis in the amphibian lens. Ophthal. Res. 14:73-82.

Rothstein, H., Worgul, B.V., Medvedovsky, C. and Merriam, G.R., Jr. (1982). G0/G1 arrest of cell proliferation in the ocular lens prevents radiation cataract development. Ophthal. Res.14:215-220.

Merriam, G.R., Worgul, B.V., Medvedovsky, C., Zaider, M. and Rossi, H. (1984). Accelerated heavy particles and the lens. I. Cataractogenic potential. Rad. Res. 98: 129-140.

Worgul, B.V., Merriam, G.R. and Medvedovsky, C. (1985). Accelerated heavy particles and the lens. II. Cytopathological changes. Invest Ophthal Vis Sci 27:108-114.

Odrich, S., Merriam, G.R., Medvedovsky, C. and Worgul, B.V. (1988). Micronucleation in the lens epithelium due to exogenous physical and chemical mutagens. Lens Res. 5:203-216

Holsclaw,D.S.,Merriam,G.R.,Medvedovsky,C.,Rothstein,H. and Worgul, B.V. (1989). Stationary radiation cataracts - an animal model. Exp. Eye Res. 48:395-398.

Worgul, B.V., Medvedovsky, C.M. and Merriam, G.R. (1989). Cortical cataract development - the expression of primary damage to the lens epithelium Lens & Eye Tox. Res. 6:559-571.

Worgul, B.V., Merriam, G.R., Medvedovsky, C. and Brenner, D. (1989). Accelerated heavy particles and the lens. III. Enhanced cataractogenesis by dose fractionation of 570 MeV/amu ^{40}Ar ions. Rad. Res. 118:93-100.

Worgul, B.V., Medvedovsky, C., Powers-Risius and Alpen, E. (1989). The effect of accelerated particles and the lens IV: Biomicroscopy and cytopathological analyses of the lenses of mice irradiated with 600 MeV/amu Iron-56 ions. Rad. Res. 120:280-293.

Brenner, D.J., Medvedovsky, C., Huang, Y., Merriam, G.R., Jr., and Worgul, B.V. (1991) Accelerated heavy particles and the lens VI: RBE studies at low dose. Rad. Res. 128:73-81.

Medvedovsky, C., and Worgul, B.V. (1991) Neutron effects on the lens. Rad. Res. 128:S103-S110.

Worgul, B.V., David, J., Odrich, S., Merriam, G.R., Jr., Medvedovsky, C., Merriam, J.C., Trokel, S.L. and Geard, C.R. (1991). Evidence of genotoxic damage in human cataractous lenses. Mutagenesis 6(6):495-499.

Worgul, B.V., Brenner, D.J., Medvedovsky, C., Merriam, G.R., Jr. and Huang, Y. (1993). Accelerated heavy particles and the lens VII: The cataractogenic potential of 450 MeV/amu iron ions. Invest. Ophthal. Vis. Sci.. 54:184

Brenner, D.J., Medvedovsky, C., Huang, Y. and Worgul, B.V. (1993) Accelerated heavy particles and the lens VIII: Comparisons between the effects of iron ions (190 keV/μm and argon ions (88 keV/μm). Rad. Res. 133:198-203.

B. Wu, C. Medvedovsky and B.V. Worgul. (1994) Non-subjective cataract analyses and its application in space radiation risk assessment. Adv. Space Res. 14:493-500.

Medvedovsky, C., Worgul, B.V., Huang, Y., Brenner, D.J., Tao, F., Miller, J., Zeitlin, C. and Ainsworth, E.J.(1994) The influence of dose, dose-rate and particle fragmentation on cataract induction by energetic iron ions. Adv. Space Res. 14:475-482.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Parkhomenko, George J.	Investigator

EDUCATION *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Kalinin State Medical Institute	M.D.	1984	Clinical Medicine
Kalinin State Medical Institute	Ph.D.	1993	Ophthalmology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1989-Present Kiev Institute of Advanced Training for Physicians, Department of Ophthalmology, Kiev, Ukraine

PUBLICATIONS: (Includes only full papers)

Sergienko, N.M., Kondratenko, U.N. and Parkhomenko, G.J. Implantation posterior chamber intraocular lenses during the loss of corpus vitreum. International Symposium on Refractive Surgery and IOL Implantation. Theses, Moscow, 1991.

Parkhomenko, G.J., Novak, L.P. and Sergienko, A.N. Method of anterior capsulectomy during ECEC and IOL implantation. International Symposium on Refractive Surgery and IOL Implantation. Theses, Moscow, 1991.

Sergienko, N.M., Kondratenko, U.N. and Parkhomenko, G.J. Results of IOL implantation during damage of posterior capsule and ECEC. International Symposium on Eye Microsurgery and Influence of Radiation on the Eye. Theses, Jaremcha, 1992.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Ruban, Andrei N.	Investigator

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Kiev State Medical Institute	M.D.	1992	Clinical Medicine

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1992-Present Post-graduate studies. Kiev Institute of Advanced Training for Physicians, Department of Ophthalmology

PUBLICATIONS: (Includes only full papers)

Pasechnikova, N.V., Ruban, A.N. Microwave therapy in treatment of diabetic retinopathy. International Conference of Young Scientists. Theses, Kiev, 1991.

Veselovskaja, Z.F., Pasechnikova, N.V. and Ruban, A.N. Results of microwave therapy in treatments of diabetic retinopathy. International Conference of Young Scientists. Theses, Kiev, 1992.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Roy E. Shore	Professor

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Houghton College	B.A.	1962	Psychology
Syracuse University	Ph.D.	1967	Psychology/Statistics
Columbia University	Dr. P.H.	1982	Epidemiology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

Professional Experience

1969 - 1987 Ranks of Associate Research Scientist, Research Scientist, Assistant Professor and Associate Professor, Institute of Environmental Medicine, New York University Medical Center, New York, New York.

1987 - Present Professor, Institute of Environmental Medicine, New York University Medical Center, New York, New York. Currently Head, Environmental Epidemiology Unit.

Honors

Fellow, American College of Epidemiology, 1982 - Present
MERIT award from NIH, 1986
Member, National Council on Radiation Protection and Measurements, 1983-Present

Selected Government & Public Advisory Committees

Member, International Commission on Radiological Protection, Committee No. 1: Radiation Risk Assessment. (1993-97).

NAS/NRC Committee on an Assessment of CDC Radiation Studies (1991-Present) (National Academy of Sciences-National Research Council).

NCI, Board of Scientific Counselors, Division of Cancer Etiology (1984-1991) (National Cancer Institute, NIH).

Current Editorial Advisory Boards, Journal of the National Cancer Institute; Cancer Epidemiology, Biomarkers & Prevention; Regulatory Toxicology and Pharmacology

Selected Publications

Upton A., Albert R., Burns F. and Shore R. (eds.). *Radiation Carcinogenesis*. New York, Elsevier, 1986.

Shore R., Hildreth N., Woodard E., Dvoretsky P., Hempelmann L. and Pasternack B. Breast cancer among women given X-ray therapy for acute postpartum mastitis. J. Natl. Cancer Inst., 77:689-696, 1986.

Shore R. Electromagnetic radiations and cancer: cause and prevention. Cancer, 62:1747-1754, 1988.

Burns F., Hosselet S., Wolman S., Perle M., Shore R. and Garte S. The radiosensitivity of skin fibroblasts from patients with multiple radiation induced skin cancers. Proc. Am. Assoc. Cancer Res. 30:771, 1989.

Shore R.E. Radiation epidemiology: old and new challenges. Environ. Health Perspec. 81:153-156, 1989.

Hildreth N., Shore R. and Dvoretsky P. Risk of breast cancer following thymic irradiation in infancy. N. Engl. J. Med. 321:1281-1284, 1989.

Greenberg H.L., Ott M. and Shore R. Men assigned to ethylene oxide production or other ethylene oxide related chemical manufacturing: a mortality study. Br. J. Indust. Med. 47:221-230, 1990.

Shore R.E. Overview of radiation induced skin cancer in humans. Int. J. Rad. Biol. 57:809-827, 1990.

Shore R.E. Occupational radiation studies: status, problems and prospects. Health Phys. 59:63-68, 1990.

Shore R.E., Harley N., Pasternack B. and Gladstein A. Skin cancer susceptibility among irradiated patients. J. Am. Acad. Dermatol. 22:859, 1990.

Shore R.E. Epidemiology of neoplasms of the foot. In: *Neoplasms of the Foot and Leg*. Cold D. and DeLauro T., Eds., Saunders, Phila. pp. 24-32, 1990.

Steinfeld A.D. and Shore R. Second malignancies following radiotherapy for testicular seminoma. Clin. Oncol. 2:273-276, 1990.

Toniolo P.G., Pasternack B., Shore R. Sonnenschein E., Koenig K., Rosenberg C., Strax P. and Strax S. Endogenous hormones and breast cancer: a prospective cohort study. Breast Cancer Res. Treat 18:S23-S26, 1991.

Koenig K.L., Pasternack B., Shore R. and Strax P. Hair dye use and breast cancer: a case control study among screening participants. Am. J. Epidemiol. 133:985-995, 1991.

Little M.P., Hawkins M., Shore R., Charles M. and Hildreth N. Time variations in the risk of cancer following irradiation in childhood. Radiat. Res. 126:304-316, 1991.

Shore R.E. The epidemiology of radiation induced thyroid cancer: research issues and needs. Brit. Inst. Radiol. Reports 22:61-66, 1991.

Fry R.J.M., Charles M., Gesell T., Hopewell J. and Shore R. The biological basis for dose limitation in the skin (International Commission on Radiological Protection, Publ. 569), Annals ICRP, 22:1-104, 1991.

Ruberman W., Crow R., Rosenberg C., Rautaharju P., Shore R. and Pasternack B. Intermittent ST depression and mortality after myocardial infarction Circulation, 85:1440-1446, 1992.

Shore R.E. Nonionizing radiation. In: *Environmental and Occupational Medicine*. Rom W. Ed., Little, Brown & Co., pp. 1093-1108, 1992.

Upton A.C., Shore R. and Harley H. The health effects of low level ionizing radiation. Annu. Rev. Pub. Health 13:127:150, 1992.

Shore R.E., Iyer V., Altshuler B. and Pasternack B. Use of human data in quantitative risk assessment of carcinogens: Impact on epidemiologic practice and the regulatory process. Regul. Toxicol. Pharmacol. 1 15:180-221, 1992.

Shore R.E., Hildreth N. and Moseson M. Studies of skin cancer and thyroid tumors after irradiation of the head and neck. Proc. Intl. Conf. Radiat. Effects Protect (Mito, Japan), pp. 77-79, 1992.

Shore R.E. Issues and epidemiologic evidence regarding radiation induced thyroid cancer. Radiat. Res. 131:98-111, 1992.

Shore R.E. Radiation and breast cancer risk. Proceedings of the President's Cancer Panel, Special Commission on Breast Cancer. N.I.H., NCI pp. 4-26, 1992.

Shore R.E., Hildreth N., Dvoretsky P., Pasternack B. and Andresen E. Benign thyroid adenomas among persons X-irradiated in infancy for enlarged thymus glands. Radiat. Res. 134:217-223, 1993.

Shore R.E., Hildreth N., Dvoretsky P., Andresen E., Moseson M. and Pasternack B. Thyroid cancer among persons given X-ray treatment in infancy for enlarged thymus glands. Am. J. Epidemiol. 137:1068-1080, 1993.

Koenig K.L., Toniolo P., Bonfrer B., Pasternack B., Shore R. and Bruning P. Reliability of serum prolactin measurements in women. Cancer Epidemiol. Biomark Prev. 2:411-414, 1993.

Shore R.E., Gardner M. and Pannet B. Ethylene oxide: an assessment of the epidemiologic evidence on carcinogenicity. Br. J. Indust. Med. 50:971-997, 1993.

Adelstein S., Boecker B., Brooks A., Kase K., Kronenberg A., McNeil B., Shore R. and Templeton W. Research needs for radiation protection, NCRP report #117. National Council on Radiation Protection and Measurements, Bethesda, MD. 1993.

Moseson M., Koenig K., Shore R. and Pasternack B. The influence of medical conditions associated with hormones on the risk of breast cancer. Int. J. Epidemiol. 22:1000-1009, 1993.

Day G.L., Blot W., Shore R., McLaughlin J., Austin D., Greenberg R., Liff J., Preston-Martin S., Sarkar S., Schoenberg J. and Fraumeni J. Second cancers following oral and pharyngeal cancer: role of tobacco and alcohol. J. Natl. Cancer Inst. 86:131-137, 1994.

Toniolo P., Koenig K., Pasternack B., Shore R., Rosenberg C. and Levitz M. Reliability of total, protein bound and unbound estradiol in serum. Cancer Epidemiol. Biomark Prev. 3:47-50, 1994.

Toniolo P., Riboli E., Shore R. and Pasternack B. Consumption of meat, animal products, protein and fat and risk of breast cancer. Epidemiol (In Press), 1994.

Day G.L., Shore R., Blot W., McLaughlin J., Austin D., Greenberg R., Liff J., Preston-Martin S., Sarkar S., Schoenberg J. and Fraumeni J. Dietary factors and second primary cancers: a follow-up of oral and pharyngeal cancer patients. Nutr. Cancer (In Press), 1994.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Sergienko Nikolai Markovich	Professor

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Medical Institute, Charkov, Ukraine	B.S.	1958	Medicine
Medical Institute, Donezk, Ukraine	Ph.D.	1964	Ophthalmology
Medical Institute, Donezk, Ukraine	M.D.	1971	Ophthalmology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1963-1972 Assistant, Dept.Ophthalmology, Donezk Medical Institute, Ukraine
1972-1977 Head, Dept.Ophthalmology, Dagestan Medical Institute, Ukraine
1978-Present Head, Dept.Ophthalmology, Kiev Institute of AdvancedTraining for Physicians, Ukraine
1978-Present Chief Ophthalmologist of Health Ministry of Ukraine, Ukraine
1982-Present Deputy Chairman of Ukranian Scientific Ophthalmological Society, Ukraine
1988-Present Founder and Chief of Kiev Eye Microsurgery Centre, Ukraine
1992-Present Corresponding Member of Academy of Science of Ukraine, Ukraine
1993-Present First Deputy Secretary of the Academy of Science of Ukraine, Ukraine

SELECTED PUBLICATIONS

Sergienko, N.M. (1975) Clinical refraction of human eye. Kiev, "Zdorovja".

Sergienko, N.M. (1978) New colour phenomenon of rod-cone antagonism. Abstract Regional symposium of the international research group on colour vision deficiencies, p.43, Dresden.

Sergienko, N.M. (1984) Diagnostic of optic atrophy, Ophthalmologichesky zjurnal, 6:339-341.

Sergienko, N.M. (1986) Artificial lens. USA Patent 4 642 115.

Sergienko, N.M., Emilit, V.A., Komjachova, A.V., and Pishel, A. (1987) Binicular functions and aniseiconia of artiphakic eyes. Vestnik Ophthalmologii, 4:15-17.

Sergienko N.M. and Pishel A. (1988) Apparent accommodation of artiphakic eye, Vestnik Opthalmologii, 5:23-26.

Sergienko, N.M. and Aliev G.D. (1989) Correcting astigmatism. American Journal of Optometry and Physiological Optics, 66:167-169.

Sergienko, N.M. and Pavljuchenko K.P. (1989) Method of treatment of secondary cataract. Vestnik Ophthalmologii, 6:23-25.

Sergienko, N.M. (1990) Intraocular lens experiments before Harold Ridley, J.Cataract Refractive Surg., 16:388-389.

Sergienko, N.M. (1990) Intra-Ocular Correction,Kiev, "Zdorovja"

Sergienko, N.M., Veselovskaja, Z.F., Stavnichuk E.Z. and Pishel A. (1990) Posterior chamber stepped IOL model-1000 cases, Implants in Opthalmology, 4:95-96.

Sergienko, N.M. (1991) Ophthalmic Optics, Kiev, "Zdorovja".

Sergienko, N.M., Veselovskaja, Z.F. and Parkhomenko, G. (1992) Implantation der Hinterkammerlinsen beim Verletzung der hinteren Kapsel, 90 Tagung der Deutschen Ophthalmologischen, Gesellschaft, Mannheim, S. 127.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Vitte, Peter N.	Investigator

EDUCATION (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Kiev Medical Institute	M.D.	1972	Clinical Medicine
Kiev Res. Inst. for Labour Hyg. & Occup. Health	Ph.D.	1988	Medical Sciences

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1978-1988 Kiev Research Institute of Labour Hygeine and Occupational Diseases, Ministry of Health, Kiev, Ukraine.

1989-Present Institute for Occupational Health, Academy of Sciences of Ukraine, Kiev, Ukraine

PUBLICATIONS: (Includes only full papers)

Vitte, P.N. The questions of labour management and hygiene at poultry farming. Znaniye, p. 16, Kiev, 1981.

Vitte, P.N. Multifactorial prevention of coronary heart disease in rural populations of the Ukraine. In: *Theses of the Reports of the First Congress of Cardiologists of Kirghis, SSR.* p. 140-141, Frunze, 1987.

Vitte, P.N. Occupational health of milk operators. Zdorovie, p. 40, Kiev, 1987.

Vitte, P.N. Cardiovascular diseases and working conditions in rural Ukrainian populations. CVD Epidemiology, Council on Epidemiology, American Heart Association, U.S.A., p. 77, 1989.

Vitte, P.N. Effects of occupational and other risk factors on the health of agricultural workers. The First Finnish-Soviet Symposium on Occupational Health and Safety in Agriculture. Proceedings 2. Inst. of Occupational Health, Helsinki, p. 28-36, 1991.

Vitte, P.N. Determination of the effects of occupational factors and obesity on the formation of cardiovascular pathology in rural workers. Labour Hygiene, Kiev, 28:81-86, 1992.

Vitte, P.N. The influence of environment and production sphere on coronary heart disease genesis in able bodied rural populations of Ukraine. International Heart Health Conference Abstract Book. IV Cardiology Congress of Ukraine, p. 122, Kiev, 1993.

Vitte, P.N. Morbidity of rural workers of the zones with radiation contaminations. *Chernobyl and People Health.* Abstracts of Ukrainian Scientific Center of Radiation Medicine Conference, p. 298, Kiev, 1993.

Vitte, P.N. Blood lead monitoring studies in Chernobyl region in 1991. Eighth International Symposium on *Trace Elements in Man and Animals.* p. 140, 1993.

BIOGRAPHICAL SKETCH

Give the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

NAME	POSITION TITLE
Wu, Bin	Research Fellow

EDUCATION *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Enshi Medical College	M.D.	1984	Medicine
Tongji Medical University	Masters	1989	Ophthalmology

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Key personnel include the principal investigator and any other individuals who participate in the scientific development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the scientific development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. DO NOT EXCEED TWO PAGES.

1979-1984 Department of Medicine, Enshi Medical College, Enshi, Hubei Province, China.

1984-1986 Resident, Dept. of Ophthalmology, the Fifth Hospital of Wuhan, Wuhan, Hubei Prov., China.

1986-1989 Graduate study. Dept. of Ophthalmology, Tongji Medical University, Wuhan, Hubei Prov. China.

1989-1990 Resident, Dept. of Ophthalmology, Tongji Medical University, Wuhan, Hubei Prov. China.

1990-1992 Chief Resident, Dept. of Ophthalmology, Tongji Medical University, Wuhan, Hubei Prov., China.

1992-Present Postdoctoral Res. Fellow. Eye Radiation and Environmental Res. Lab.. Columbia University.

PUBLICATIONS: (Includes only full papers)

Wu, B. and Hu, C. (1990). Early radiation effects on rabbits lens. Chinese Journal of Radiological Medicine and Protection. 10:325-326.

Tang, S., Hu, C. and Wu, B. (1990). *In vivo* observations of the subacute irradiation on rabbit lens. Chinese Journal of Injuries and Occupational Diseases of the Eye. 12:275-277.

Eong, J., Hu, C. and Wu, B. (1990). The experimental study on the relationship between the prostaglandin and the injury on the cornea. Chinese Journal of Injuries and Occupational Diseases of the Eye. 12:331-333.

Hu, C. and Wu, B. (1991). Ultrastructural observations on retina after low dose gamma irradiation. Chinese Journal of Injuries and Occupational Diseases of the Eye. 13:235-237.

Wu, B., Medvedovsky, C. and Worgul, B. (1994). Non-subjective cataract analysis and its application in space radiation risk assessment. Adv. Space Res. 14:493-500.

LITERATURE CITED

Adamson, I., Munoz, B., Enger, C. and Taylor, H. (1991). Prevalence of lens opacities in surgical and general populations. Arch. Ophthal. 109:993-997.

Bellows, J.G. and Bellows, R.J. (1975). Presenile and senile cataract - the aging lens: clinical considerations. In: Cataract and Abnormalities of the Lens. pp. 303-313, ed. J.G. Bellows, Grume and Stratton, New York.

Brenner, D.J., Medvedovsky, C., Huang, Y., Merriam, G.R., Jr., and Worgul, B.V. (1991) Accelerated heavy particles and the lens VI: RBE studies at Low Dose. Rad. Res. 128: 73-81.

Brenner, D.J., Medvedovsky, C., Huang, Y. and Worgul, B.V. (1993) Accelerated heavy particles and the lens VIII. Comparisons between the effects of iron ions (190 keV/μm) and argon ions (88 keV/μm). Rad. Res. 133:198-203.

Choshi, K., Takaku, I., Mishima, H., Takase, T., Nerlishi, S., Finch, S. and Otake, M. (1983). Ophthalmologic changes related to radiation exposure and age in Adult Health Study sample, Hiroshima and Nagasaki. Radiat. Res. 96:560-579.

Christen, W.G., Munson, J.E., Seddon, J.M., et al. (1992) A prospective study of cigarette smoking and risk of cataract in men. JAMA 268:989-993.

Cinotti, A.A. and Patti, J.C. (1968). Lens abnormalities in an aging population of nonglaucomatous patients. Amer. J. of Ophthal. 65:25-32.

Cogan, D. (1950). Lesions of the eye from radiant energy. JAMA 142U145-151.

Cogan, D.G., Donaldson, D.D. and Reese, A.B. (1952). Clinical and pathologic characteristics of radiation cataract. Arch. Ophthal. 47:55-70.

Cogan, D.G., Martin, S. and Kimura, S. (1949). Atomic bomb cataracts. Science 110:654-655.

Day, R. Gorin, M.B. and Eller, A.W. (Submitted) Prevalence of lens changes in Ukrainian Children residing around Chernobyl.

Dodo, T. (1975) Review of thirty years study of Hiroshima and Nagasaki atomic bomb survivors II. Biological effects. H. Cataracts. J. Radiat. Res. 16:132-137.

Donaldson, D.D. (1976). In: The Crystalline Lens. C.V. Mosby, St. Louis.

Eller, A.W., Day, R. and Gorin, M.B. (1993). A cross-sectional study of lens changes in children from exposed and non-exposed regions of surrounding the Chernobyl Nuclear Reactor. Inv. Ophthal. Vis. Sci. 34:1065.

Ehrenberg, A.S.C. (1982) Discussion of Brown, "Multivariate calibration". J.R.S.S. Series B. 44:311-312.

Goldman, H. (1937). Studien uber den allerskernstreifen der linse. Arch. Augenheilk. 110:405-414.

Gudi, R., Sandhu, S.S., and Athwal, R.S. (1990). Kinetochore identification in micronuclei in mouse bone-marrow erythrocytes: An assay for the detection of aneuploidy-inducing agents. Mut. Res. 234:263-268.

Gudi, R., Xu, J. and Thilagar, A. (1992). Assessment of the *in vivo* aneuploidy/micronucleus assay in mouse bone marrow cells with 16 chemicals. Environ. and Molecular Mutagenesis, 20:106-116.

Hankinson, S., Stampfer, M., Seddon, J., Colditz, G., Rosner, B., Speizer, F. and Willett, W. (1992) Nutrient intake and cataract extraction in women: a prospective study. Br. Med. J. 305:335-339.

Hankinson, S.E., Willett, W.C., Colditz, G.A., et al. (1992) A prospective study of cigarette smoking and risk of cataract surgery in women. JAMA 268:994-998.

Hiller, R., Sperduto, R. and Ederer, F. (1983) Epidemiologic associations with cataract in the 1971-1972 National Health and Nutrition Examination Survey. Am. J. Epidemiol. 118:239-249.

Holsclaw, D.S., Merriam, G.R., Medvedovsky, C., Rothstein, H. and Worgul, B.V. (1989) Stationary radiation cataracts - as animal model. Exp. Eye Res. 48:395-398.

Holsclaw, D.S., Medvedovsky, C., Rothstein, H. and Worgul, B.V. (In Press) Hormonal modification of clinical and cytopathological changes in radiation induced cataracts. Exp. Eye Res.

Hutchinson, F. (1973). The lesions produced by ultraviolet light in DNA containing 5-Bromouracil. Q. Rev. Biophys. 6:201-246.

Isaac, N., Walker, A., Jick, H. and Gorman, M. (1991). Exposure to phenothiazine drugs and risk of cataract. Arch. Ophthalmol. 109:256-260.

Italian-American Cataract Study Group (1991) Risk factors for age related cortical, nuclear, and posterior subcapsular cataracts. Am. J. Epidemiol. 133:541-553.

Jacques, P. and Chylack, L. (1991) Epidemiologic evidence of a role for the antioxidant vitamins and carotenoids in cataract prevention. Am. J. Clin. Nutr. 53:352-355.

Klein, B.E.K., Klein, R., Linton, K.L.P. and Franke, T. (1993) Diagnostic X-ray exposure and lens opacities: The Beaver Dam eye study. Am. J. Public Health 83:588-590.

Klein, B.E., Klein, R. and Linton, K. (1992). Prevalence of age related lens opacities in a population. The Beaver Dam Eye Study. Ophthalmol. 99:546-552.

Klein, B.E.K., Klein, R., Linton, K.L.P. and Franke, T. (1993) Cigarette smoking and lens opacities: the Beaver Dam eye study. Am. J. Prev. Med. 9:27-30.

Krueger, D.E., Milton, R. and Maunder, L. (1980). The Framingham Eye Study: Introduction to the monograph. Surv. Ophthalmol. 24:614-620.

Kwasha, E.A. (1987) Mortality rate from IHD in 40-59 year old males. Ph.D. Dissertation

Kwasha, E. A., Smirnova, I. P. and Gorbas, I. L. (1994) Mortality rate from primary CVD in relation to the risk profile of the male population. Ukr. J. Cardiol. 1:90-92

Lagakos, S.W. (1988) Effects of mismodelling and mismeasuring explanatory variables on tests of their association with response variable. Stat. Med. 7:257-274.

Leibowitz, H.M., Krueger, D., Maunder, L., Milton, R., Kini, M., Kahn, H., Nickerson, R., Pool, J. and Colton, T. (1980). The Framingham Eye Study monograph: an ophthalmological and epidemiological study of cataract, glaucoma, diabetic retinopathy, macular degeneration, and visual acuity in a general population of 2631 adults. Surv. Ophthalmol. 24:335-610.

Leske, M., Chylack, L. and Wu, S. (1991) The lens opacities case-control study. Risk factors for cataract. Arch. Ophthalmol. 109:244-251.

Lubin, J.H. and Gail, M. (1984) Biased selection of controls for case-control analyses of cohort studies. Biometrics 40:63-75.

Manski, W., York, A.T., Merriam, G.R., Jr., Worgul, B.V. and Szechter, A. (1976). On the independent action of cataractogenic agents. X-rays and galactose. In: Progress of Lens Biochemistry Research, Doc. Ophthal. Proc. Ser., O. Hockwin, Dr.., Junk Pub., The Hague, Vol. 8, pp. 275-292.

Medvedovsky, C. and Worgul, B.V. (1991) Neutron effects on the lens. Rad. Res. 128:S103-S110.

Merriam, G.R., Jr. and Worgul, B.V. (1983). Experimental radiation cataract - its clinical relevance. Bull. N.Y. Acad. Med. 59:372-392.

Merriam, G.R., Szechter, A. and Focht, E. (1972). The effects of ionizing radiations on the eye. Front Radiat. Ther. Oncol. 6:346-385.

Merriam, G.R., Jr. and Focht, E. (1957). A clinical study of radiation cataracts and the relationship to dose. Am. J. Roentgenol. Radium Ther. Nucl. Med. 77:759-785.

Miller, R.J., Funijo, T. and Nefzger, M. (1967). Lens findings in atomic bomb survivors: A review of major ophthalmic surveys at the Atomic Bomb Casualty Commission (1949-1962). Arch. Ophthalmol 78:697-704.

Munoz, B., Tajchman, U., Bochow, T. and West, S. (1993). Alcohol use and risk of posterior subcapsular cataracts. Arch. Ophthal. 111:110-112.

Murray, D., Prager, A., Altschuler, E.M. and Brock, W.A. (1991). Effect of thiols on micronucleus frequency in γ-irradiated mammalian cells. Mut. Res. 247:167-173.

Nam, J. (1987). A simple approximation for calculating sample sizes for detecting linear trend in proportions. Biometrics 43:701-705.

National Cancer Institute (1993). Health Habits and History Questionnaire: Diet History and Other Risk Factors - Personal Computer System Packet. Version 3.0

Nordmann, J. and Mandel, P. (1955) Enzyme studies in radiation cataract. Am. J. Ophthal. 40:871-880.

Odrich, S., Medvedovsky C., Merriam, G.R., Jr., and Worgul, B.V. (1988). Micronucleation in the lens epithelium following *in vivo* exposure to physical and chemical mutagens. Lens Res. 5(3-4):203-216.

Okada, S. (1970). Radiation Biochemistry. In: Cells, Vol. 1, Academic Press, New York.

Omelyanets, N.I., Misetskij, G.I., Saurov, M.M. and Tabin, V.F. (1988). Medical demographic consequences of the Chernobyl accident In: Medical Aspects of the Chernobyl Accident. Report-IAEA-TEDOC-516, pp. 315-326.

Otake, M., Finch, S., Chosi, K., Takaku, I., Mishima, H. and Takase, T. (1992). Radiation related ophthalmological changes and aging among Hiroshima and Nagasaki A-bomb survivors: a reanalysis. Radiat. Res. 131:315-324.

Otake, M. and Schull, W. (1990). Radiation related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on the DS86 dosimetry system. Radiat. Res. 121:3-13.

Otake, M. and Schull, W. (1982). The relationship of gamma and neutron radiation to posterior lenticular opacities among atomic bomb survivors in Hiroshima and Nagasaki. Radiat. Res. 92:574-595.

Podgor, M.J., Leska, M. and Ederer, F. (1983). Incidence estimates for lens changes, macular changes, open angle glaucoma and diabetic retinopathy. Am. J. Epidemiol. 118:206-212.

Ramalho, A., Sunjevaric, I. and Natarajan, A.T. (1988). Use of the frequencies of micronuclei as quantitative indicators of X-ray induced chromosomal aberrations in human peripheral blood lymphocytes: comparison of two methods. Mut. Res. 207:141-146.

Ritter, L., Klein, B., Klein, R. and Mares-Perlman, J. (1993) Alcohol use and lens opacities in the Beaver Dam Eye Study. Arch. Ophthalmol. 111:113-117.

Robins, J., Gail, M. and Lubin J. (1986) More on biased selection of controls for case-control analyses of cohort studies. Biometrics 42:293-299.

Rothstein, H., Worgul, B.V. and Weinsieder, A. (1982). Regulation of lens morphogenesis and cataract pathogenesis by pituitary dependent, insulin-like, mitogens. In: Cellular Communication During Ocular Development, eds. Sheffield, J. and Hilfer, S., Springer-Verlag, New York.

Schimizu, Y., Kato, H. and Schull, W. (1990). Studies of the mortality of A-bomb survivors. 9. Mortality, 1950-1985: Part 2, cancer mortality based on the recently revised doses (DS86). Radiat. Res. 121:120-141.

Sergeev, G.V. (1988). Medical and sanitary measures taken to deal with the consequences of the Chernobyl accident. In: Medical Aspects of the Chernobyl Accident. Report - IAEA-TEDOC-516, pp. 23-38.

Shlaifer, A. (1954). Cataract and its etiology. Am. J. Optometry 31:437-458.

Smirnova, I.P., Kwasha, E.A. and Gorbas, I.M. (1990) Comparison of mortality modelling for IHD and results a 10 year prospective study. XI Congress of Cardiology, Manila

Sperduto, R.D. and Hiller, R. (1984). The prevalence of nuclear, cortical and posterior subcapsular lens opacities in a general population sample. Ophthal. 91:815-818.

Stark, W.J., Sommer, A., and Smith, R.E. (1989) Changing trends in intraocular lens implantation. Arch. Ophthal. 107:1441-1444.

Stevens, W., Till, J., Thomas, D., Lyon, J., Kerber, R., Preston-Martin, S., Simon, S., Rallison, M. and Lloyd, R. (1992). Report of a cohort study of thyroid disease and radioactive fallout from the Nevada Test Site. University of Utah, report to the National Cancer Institute, Salt Lake City, Utah (submitted for publication).

Streeten, B.W. and Eshaghian, J. (1978). Human posterior subcapsular cataract. Arch. Ophthal. 96:1653-1658.

Tao, F., Medvedovsky, C., David, J., Broglio, T., Powers-Risius, P., Alpen, E.L. and Worgul, B.V. (1993) Accelerated heavy ions and the lens: IX The late effect of LET and dose on cellular parameters in the murine lens. Int. J. Rad. Biol. 64:103-111.

Thompson, D., Mabuchi, K., Ron, E., Soda, M., Tokunaga, M., Ochikubo, S., Sugimoto, S., Ikeda, T. and Terasaki, M. (1993). Solid tumor incidence in A-bomb survivors, 1958-1987. Radiat. Res. (In Press).

Tomanin, R., Ballarin, C., Nardini, B., Mastrangelo, G. and Sarto, F. (1991). Influence of smoking habit on the frequency of micronuclei in human lymphocytes by the cytokinesis block method. Mutagenesis 6:123-126.

von Sallmann, L. (1950). Experimental studies on early lens changes after X-ray irradiation. Tr. Am. Ophthal. Soc. 48:228-242.

von Sallmann, L. (1951a). Experimental studies on early lens changes after Roentgen irradiation. Arch. Ophthal. 45:149-164.

von Sallmann, L. (1951b). Experimental studies on early lens changes after Roentgen irradiation. III. Effect of X-radiation on mitotic activity and nuclear fragmentation of lens epithelium in normal and cysteine treated rabbits. Arch. Ophthal. 47:305-320.

von Sallmann, L. (1957). The lens epithelium in the pathogenesis of cataract. The XIII Edward Jackson Memorial Lecture. Am. J. Ophthal. 44:159-170.

Worgul, B.V. (1982). The Lens. In: Biomedical Foundations of Ophthalmology, Vol. I, Chapter 15, pp.1-35, eds., Duane, T. and Jakobiec, F., J.B. Lippincott, Co., Philadelphia.

Worgul, B.V., Brenner, D.J., Medvedovsky, C., Merriam, G.R., Jr. and Huang, Y. (1993) Accelerated heavy particles and the lens VII: The cataractogenic potential of 450 MeV/amu iron ions. Invest. Ophthal. Vis. Sci. 34:184-193.

Worgul, B.V., David, J., Odrich, S., Merriam, G.R., Jr., Medvedovsky, C., Merriam, J.C., Trokel, S.L. and Geard, C.R. (1991). Evidence of genotoxic damage in human cataractous lenses. Mutagenesis 6(6):495-499.

Worgul, B.V., Medvedovsky, C.M. and Merriam, G.R. (1989). Cortical cataract development - the expression of primary damage to the lens epithelium Lens & Eye Tox. Res. 6: 559-571.

Worgul, B.V., Merriam, G.R., Jr., Szechter, A. and Srinivasan, B.D. (1976). The lens epithelium and radiation cataract I. Preliminary studies. Arch. Ophthal. 94:996-999.

Worgul, B.V., Merriam, G.R., Jr., Medvedovsky, C. and Brenner, D.J. (1989). Accelerated heavy particles and the lens III. Cataract enhancement by dose fractionation. Rad. Res. 118:93-100.

Worgul, B.V. and Rothstein, H. (1974). On the mechanism of thyroid mediated mitogenesis in adult anura. I. Preliminary analyses of growth kinetics and macromolecular synthesis, in lens epithelium, under the influence of exogenous triiodothyronine. Cell and Tissue Kinetics 7:415-425.

Worgul, B.V. and Rothstein, H. (1975). Radiation cataract and mitosis. Ophthal. Res. 7:21-32.

Worgul, B.V. and Rothstein, H. (1977). On the mechanism of radiocataractogenesis. Medikon 6:5-14.

Wu, B., Medvedovsky, C. and Worgul, B.V. (1994) Non-subjective cataract analyses and its application in space radiation risk assessment. Adv. Space Res. 14:493-500.

Zar, J.H. (1984) Biostatistical Analysis (Second Edition). Prentice-Hall, Englewood Cliffs, NJ, 1984.

TOOTH IDENTIFICATION FORM

1. Complete affiliation of the hospital which performed extraction

2. ID number _________ 3. Date of extraction ___/___/___

N	General information	Fragment 1
1	Family name	
2	First name	
3	Second name	
4	Sex (male - 1, female - 2)	
5	Date of birth	
6	Liquidators pass (series and number)	
7	Year of work in Chernobyl	
8	Dose value, officially recorded (if available)	
9	Date of evacuation from the 30-km zone	
10	From what settlement	

N	Postal address at present time	Fragment 2
1	ZIP code	
2	Region	
3	District	
4	Town	
5	Street	
6	House	
7	Building	
8	Apartment	

4. Places of stay since the accident (region, district, settlement)

(1986 in all details, afterwards - reflect locations with period of stay more than 3 months).

Year	Settlement	Period of stay	
		Arrival	Departure

5. Professional contact with radiation (including military service)

____

6. Information about X-ray examinations of skull, jaws, teeth (dates, type, approximate number during life span):____

____

7. General diseases affecting solid tissues of tooth

____

____

____

8. Location of the tooth and reason of extraction:

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

9. Affiliation during the Chernobyl recovery activities

10. Notes ____

11. Name of physician who extracted the tooth ____________________

Ukrainian/English Lens Examination Forms

⇒ 2 pages

⇒ Ukrainian Top Sheet
⇒ Black Carbon
⇒ English Bottom Sheet

⇒ Horizontal (Top) Tear-away
⇒ 3 Hole Punch - Left Margin

ОСМОТР ХРУСТАЛИКА

(Биомикроскопия с расширенным зрачкои > 5 мм)

ВИЗИТ	ДАТА	ИССЛЕДОВАТЕЛЬ	ФАМИЛИЯ БОЛЬНОГО	КОД

ИЗМЕНЕНИЯ ХРУСТАЛИКА	ПРАВЫЙ ГЛАЗ		ЛЕВЫЙ ГЛАЗ	
ПРОЗРАЧНЫЙ	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Ранние изменения	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
1.Полихр.переливч. в плоск. задн.капс.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
2.Единичные точки в коре (менее 10)				
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
экваториальная область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
область вокруг ядра	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
3.Единичные вакуоли (менее 5)				
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
экваториальная область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
область вокруг ядра	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ПЕРВАЯ СТАДИЯ	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Небольшое пятно обнар. при ретроиллюминации	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Небольшое пятно обнар.щелевой лампой				
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
экваториальная область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
область вокруг ядра	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ядро	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Скопление точек (>10) и/или вакуолей (>5), гран.помутн., пятна в коре, водяные щели (видимые со щелевой лампой):				
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
экваториальная область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
область вокруг ядра	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ядро	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐

LENS EXAMINATION

(Biomicroscopy with dilated pupil > 5 mm)

VISIT #	VISIT DATE	INVESTIGATOR	[redacted]	CODE

LENS CHANGES	RIGHT EYE	LEFT EYE
CLEAR	NO ☐ YES ☐	NO ☐ YES ☐
Early changes	NO ☐ YES ☐	NO ☐ YES ☐
1.Polychrom. Sheen in Post.Cap.plane	NO ☐ YES ☐	NO ☐ YES ☐
2.Individual dots in cortex (fewer than 10)		
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Equatorial	NO ☐ YES ☐	NO ☐ YES ☐
Supranuclear	NO ☐ YES ☐	NO ☐ YES ☐
3.Individual vacuoles (fewer than 5)		
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Equatorial	NO ☐ YES ☐	NO ☐ YES ☐
Supranuclear	NO ☐ YES ☐	NO ☐ YES ☐
STAGE 1:	NO ☐ YES ☐	NO ☐ YES ☐
Small, opacity seen by ophthalmoscopy	NO ☐ YES ☐	NO ☐ YES ☐
Small opacity (seen by slit lamp biomicroscopy)		
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Equatorial	NO ☐ YES ☐	NO ☐ YES ☐
Supranuclear	NO ☐ YES ☐	NO ☐ YES ☐
Nuclear	NO ☐ YES ☐	NO ☐ YES ☐
Aggregate of dots (>10) and\or vacuoles (>5), granulated opacities, cortical spots, waterclefts (seen with a slit lamp):		
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Equatorial	NO ☐ YES ☐	NO ☐ YES ☐
Supranuclear	NO ☐ YES ☐	NO ☐ YES ☐
Nuclear	NO ☐ YES ☐	NO ☐ YES ☐

ВИЗИТ	ДАТА	ИССЛЕДОВАТЕЛЬ	ФАМИЛИЯ БОЛЬНОГО	КОД

ИЗМЕНЕНИЯ ХРУСТАЛИКА	ПРАВЫЙ ГЛАЗ		ЛЕВЫЙ ГЛАЗ	
ВТОРАЯ СТАДИЯ Более значит. изменения, занимающие 1/8-1/4 части коры хрусталика. Незначит. затруднения при офтальмоскопии и исследовании стекловидного тела.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
экваториальная область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
супрануклеарный участок	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Значит.изменения в ядре	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ТРЕТЬЯ СТАДИЯ: Значит. более выраж. изменения. Офтальмоскопия возможна только в случ. прозр. или полупрозрачных участков, позволяющих исслед. стекл. тело и глазное дно.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
передняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
задняя область	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ядро	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ЧЕТВЕРТАЯ СТАДИЯ: Почти зрелая катаракта - почти полное помутнение хрусталика. На некоторых участках можно видеть ядро или заднюю часть коры хрусталика.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
ПЯТАЯ СТАДИЯ: Зрелая катаракта - полное помутнение хрусталика.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐

ПРЕДПОЛАГАЕМАЯ ЭТИОЛОГИЯ?

1.Старческие или возрастные изменения ______________________

2.Врожденные или ювенильные изменения ______________________

3.Травматическая катаракта ______________________

4.Катаракта, связанная с внутриглазными заболеваниями: ______________________

5.Катаракта, связанная с системными расстройствами: ______________________

6.Изменения, вызванные вредными агентами (ионизирующей радиацией, лекарствами, токсическими веществами и т.д.):

____

Подпись главного исследователя *Дата*

FORM UACOS93-EP

VISIT #	VISIT DATE	INVESTIGATOR	[redacted]	CODE

LENS CHANGES	RIGHT EYE	LEFT EYE
STAGE 2: More extensive changes collectively occupy the equivalent of 1/8-1/4 of the lens cortex. Little interference with ophthalmoscopy and vitreus visualization.	NO ☐ YES ☐	NO ☐ YES ☐
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Equatorial	NO ☐ YES ☐	NO ☐ YES ☐
Supranuclear	NO ☐ YES ☐	NO ☐ YES ☐
Extensive changes in the nucleus	NO ☐ YES ☐	NO ☐ YES ☐
STAGE 3: Advanced changes. Ophthalmoscopy could be performed only when clear or semi-transparent areas allow visualization of the vitreous and fundus.	NO ☐ YES ☐	NO ☐ YES ☐
Anteriorly	NO ☐ YES ☐	NO ☐ YES ☐
Posteriorly	NO ☐ YES ☐	NO ☐ YES ☐
In Nucleus	NO ☐ YES ☐	NO ☐ YES ☐
STAGE 4: Premature cataract - almost total opacification of the lens. In some areas it is possible to see the nucleus or posterior cortex of the lens.	NO ☐ YES ☐	NO ☐ YES ☐
STAGE 5: Mature cataract - total opacification of the lens.	NO ☐ YES ☐	NO ☐ YES ☐

SUGGESTED ETIOLOGY?

1.Senile or age related changes ______________________

2.Congenital or juvenile changes ______________________

3.Traumatic cataract ______________________

4.Cataract associated with intraocular disease: ______________________

5.Cataract associated with systemic disorders: ______________________

6.Changes caused by noxious agents (ionizing radiation, drug induced, toxic agents, etc.):

____

Signature of Principal Investigator	*Date*

FORM UACOS93-EP

Ukrainian/English General Eye Examination Forms

⇒ 3 pages

⇒ Ukrainian Top Sheet
⇒ Black Carbon
⇒ English Bottom Sheet

⇒ Horizontal (Top) Tear-away
⇒ 3 Hole Punch - Left Margin

ОСМОТР ГЛАЗА

ВИЗИТ	ДАТА	ИССЛЕДОВАТЕЛЬ	ФАМИЛИЯ БОЛЬНОГО	КОД

История болезни: До 1986 (заболевания глаза, операция, и.т.д.)

После 1986 (то же, более детально)

	Правый глаз		Левый глаз	
Жалобы				
Сухость	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Слезоточивость	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Отделяемое	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Боль				
Глазная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Вокруг глазного яблока	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Пятна перед глазом				
Смещающиеся с движ. глаз	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Плавающие	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Снижение зрения				
Центрального	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Переферического	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Другие жалобы (описать)				
________________	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Острота зрения				
Нормальная (1.0-0.8)	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
б/коррекции				
<0.1	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
0.1-0.5	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
>0.5	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
с коррекцией				
OD________________				
________________				
OS________________				
________________				
<0.1	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
0.1-0.5	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
>0.5	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐

EYE EXAMINATION

VISIT #	VISIT DATE	INVESTIGATOR	[redacted]	CODE

HISTORY: Before 1986 (eye disease, surgery, etc)

After 1986 (same, in more detail)

	Right eye		Left eye	
Complaints				
Dryness	NO ☐	YES ☐	NO ☐	YES ☐
Tearing	NO ☐	YES ☐	NO ☐	YES ☐
Discharge	NO ☐	YES ☐	NO ☐	YES ☐
Pain				
Ocular	NO ☐	YES ☐	NO ☐	YES ☐
Periocular	NO ☐	YES ☐	NO ☐	YES ☐
Spots				
Shifts with eye movement	NO ☐	YES ☐	NO ☐	YES ☐
Floating	NO ☐	YES ☐	NO ☐	YES ☐
Reduced Vision				
Central	NO ☐	YES ☐	NO ☐	YES ☐
Peripheral	NO ☐	YES ☐	NO ☐	YES ☐
Other complaints(specify)				
________________________	NO ☐	YES ☐	NO ☐	YES ☐
Visual Acuity				
Normal (1.0 - 0.8)	NO ☐	YES ☐	NO ☐	YES ☐
Without Glasses				
<0.1	NO ☐	YES ☐	NO ☐	YES ☐
0.1-0.5	NO ☐	YES ☐	NO ☐	YES ☐
>0.5	NO ☐	YES ☐	NO ☐	YES ☐
With Glasses				
R.E.________________________				
________________________				
L.E.________________________				
________________________				
<0.1	NO ☐	YES ☐	NO ☐	YES ☐
0.1-0.5	NO ☐	YES ☐	NO ☐	YES ☐
>0.5	NO ☐	YES ☐	NO ☐	YES ☐

ОСМОТР ГЛАЗА

ВИЗИТ	ДАТА	ИССЛЕДОВАТЕЛЬ	ФАМИЛИЯ БОЛЬНОГО	КОД

	Правый глаз		Левый глаз	
Рефракция (эмметропия)	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Миопия	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
>6.0 D	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Гиперметропия	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Астигматизм	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Пресбиопия	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Поле зрения				
Нормальное	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если нет, используйте схему				
Внутриглазное давление (указать тонометр) ______________________				
<20 мм рт.ст.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
20-24 мм рт.ст.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
25-28 мм рт.ст.г	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
>28 мм рт.ст.	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Ресницы				
Нормальные	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если НЕТ ______________________ ______________________				
Веки				
Нормальные	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если НЕТ ______________________ ______________________				
Слезные пути				
Нормальные	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если НЕТ______________________ ______________________				
Коньюктива				
Нормальная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Воспаленная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Фолликулез	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Пингвекула	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Телеангиоэктазии	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Прочее(перикор.инъекция, и т,д,)	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Передняя камера				
Нормальная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если НЕТ______________________ ______________________				

EYE EXAMINATION

VISIT #	VISIT DATE	INVESTIGATOR	[redacted]	CODE

	RIGHT EYE		LEFT EYE	
Refraction: (Emmetropia)	NO ☐	YES ☐	NO ☐	YES ☐
Myopia	NO ☐	YES ☐	NO ☐	YES ☐
>6.0 D	NO ☐	YES ☐	NO ☐	YES ☐
Hypermetropia	NO ☐	YES ☐	NO ☐	YES ☐
Astigmatism	NO ☐	YES ☐	NO ☐	YES ☐
Presbyopia	NO ☐	YES ☐	NO ☐	YES ☐
Visual Field				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO use diagram page				
Intraocular Tension (specify tonometer)				
______________________________				
<20 mm Hg	NO ☐	YES ☐	NO ☐	YES ☐
20-24 mm Hg	NO ☐	YES ☐	NO ☐	YES ☐
25-28 mm Hg	NO ☐	YES ☐	NO ☐	YES ☐
>28 mm Hg	NO ☐	YES ☐	NO ☐	YES ☐
Eyelashes				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO				
______________________________				
______________________________				
Eyelids				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO				
______________________________				
______________________________				
Lacrimal Structure				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO__________________________				
______________________________				
Conjunctiva				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
Injected	NO ☐	YES ☐	NO ☐	YES ☐
Folliculosis	NO ☐	YES ☐	NO ☐	YES ☐
Pingueculum	NO ☐	YES ☐	NO ☐	YES ☐
Telangiectasis	NO ☐	YES ☐	NO ☐	YES ☐
Other (pericorneal injection, etc.)	NO ☐	YES ☐	NO ☐	YES ☐
Anterior Chamber				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO__________________________				
______________________________				

ОСМОТР ГЛАЗА

ВИЗИТ	ДАТА	ИССЛЕДОВАТЕЛЬ	ФАМИЛИЯ БОЛЬНОГО	КОД

	Правый глаз		Левый глаз	
Роговица				
Нормальная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Кератит	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Помутнение	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Преципитаты	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Прочее ____________	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
____________				
Движения глаз				
Нормальные	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если нет ____________				
____________				
Радужная оболочка				
Нормальная	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Синехии	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Прочее ____________	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
____________				
Зрачок				
Нормальный	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Мидриаз	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Анизокория	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Нормальный зрачк. рефлекс	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Хрусталик (смотреть др. форму)				
Стекловидное тело				
Нормальное	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Структурные изменения	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
____________				
____________				
Глазное дно				
Нормальное	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Если НЕТ ____________				
____________				
Зрительный нерв	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Макула	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Сосуды	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
Прочее	НЕТ ☐	ДА ☐	НЕТ ☐	ДА ☐
____________				

ЗАКЛЮЧЕНИЕ:

Можно ли расширить зрачок ?	НЕТ ☐	ДА ☐
Можно ли сделать биомикроскопию ?	НЕТ ☐	ДА ☐
Можно ли провести исследование с Шеймпфлуг щелевой лампой?	НЕТ ☐	ДА ☐

Подпись главного исследователя	*Дата*

FORM UACOS93-EP

EYE EXAMINATION

VISIT #	VISIT DATE	INVESTIGATOR	[redacted]	CODE

	RIGHT EYE		LEFT EYE	
Cornea				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
Keratitis	NO ☐	YES ☐	NO ☐	YES ☐
Opacification	NO ☐	YES ☐	NO ☐	YES ☐
Precipitates	NO ☐	YES ☐	NO ☐	YES ☐
Other ______________________	NO ☐	YES ☐	NO ☐	YES ☐
______________________________				
Eye Movement				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO______________________				
______________________________				
Iris				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
Synechia	NO ☐	YES ☐	NO ☐	YES ☐
Other______________________	NO ☐	YES ☐	NO ☐	YES ☐
______________________________				
Pupil				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
Mydriatic	NO ☐	YES ☐	NO ☐	YES ☐
Anisocoria	NO ☐	YES ☐	NO ☐	YES ☐
Normal Pupillary Reflex	NO ☐	YES ☐	NO ☐	YES ☐
Lens (see separete from)				
Vitreous Body				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
Structural changes (opacif., etc)	NO ☐	YES ☐	NO ☐	YES ☐
______________________________				
______________________________				
Fundus				
Normal	NO ☐	YES ☐	NO ☐	YES ☐
If NO______________________				
______________________________				
Optic Nerve	NO ☐	YES ☐	NO ☐	YES ☐
Macula	NO ☐	YES ☐	NO ☐	YES ☐
Vessels	NO ☐	YES ☐	NO ☐	YES ☐
Other	NO ☐	YES ☐	NO ☐	YES ☐
______________________________				

CONCLUSION:	**Is it possible to dilate the pupil?**	NO ☐	YES ☐
	Is it possible to perform biomicroscopy?	NO ☐	YES ☐
	Is it possible to image the anterior segments?	NO ☐	YES ☐

Signature of Principal Investigator	*Date*

FORM UACOS93-EP